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PLANT OF P. SCHOENHOFEN BREWING CO.

Central Plant for Furnishing Brewery Buildings with Heat, Light, Power and Refrigeration

LARGE REFRIGERATING CAPACITY and the necessity of supplying a continuous demand for exhaust steam for hot water and heating purposes are the principal factors aside from the usual power demands, which are to be considered in the construction of the power plant for the brewery. The plant of the P. Schoenhofen Brewing Co., West Eighteenth St., Chicago, furnishes an excellent example of the manner in which these conditions have been met.

General Arrangement

LOCATED in the approximate center of the 28 buildings comprising the total plant which occupies an area of about 5 city blocks, the engine and boiler rooms are situated on the street level in separate buildings, divided by an alley, both being well lighted and ventilated. The engine room is divided into 3 parts, as shown in Fig. 2, and contains the 2 generating units, feed-water heaters, air compressors, carbon dioxide compressor, pumps, and ice machines having a total rated capacity of 920 tons. In the old boiler room is

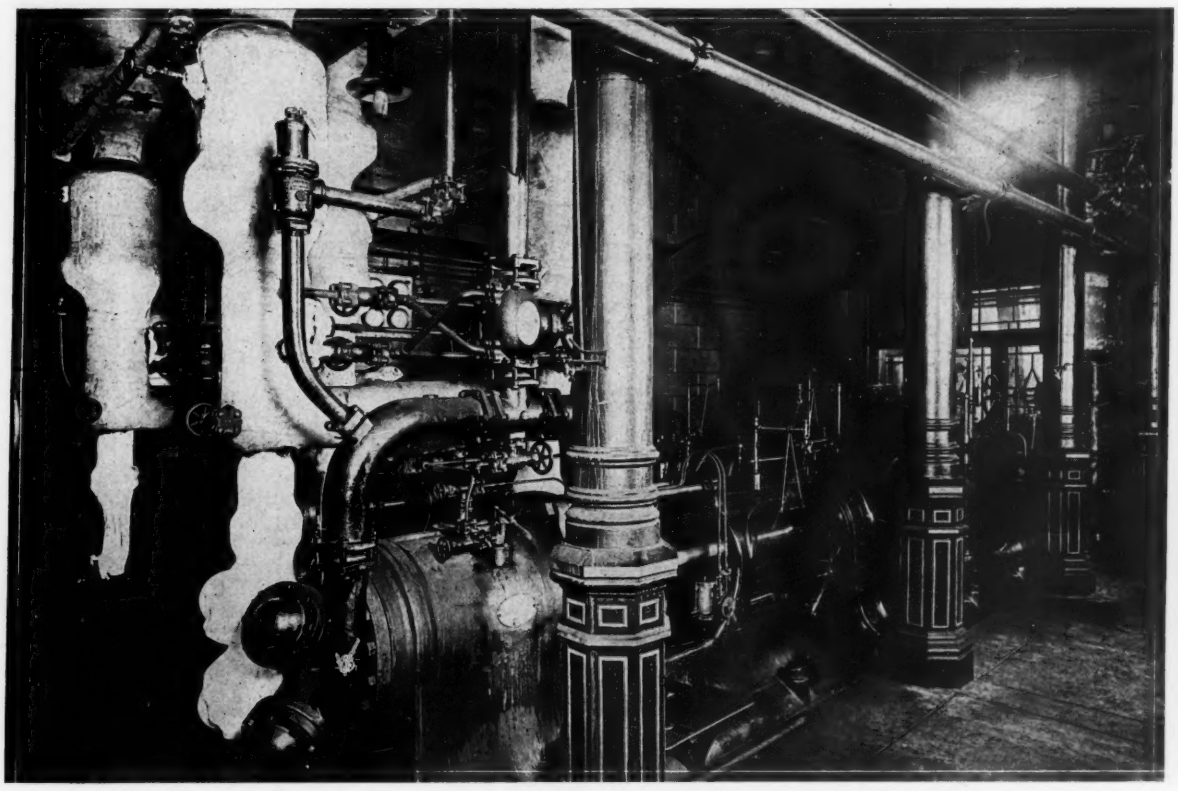


FIG. 1. VIEW OF VILTER 350 TON ICE MACHINE SHOWING PIPING ARRANGEMENT

the original equipment of 4 boilers and in the new room adjoining, which has been recently added, are 2 more boilers, constituting a total capacity of 2600 hp. Provision has also been made for an addition to the boiler house, should the load of the plant necessitate a larger steam capacity. The chimneys, one from each room, are of steel and respectively 10 ft. and 11 ft. in diameter and 175 ft. in height.

Boilers

OLDER equipment of the boiler room consists of 4 Babcock & Wilcox water-tube boilers rated at 400 hp. each and having 75 sq. ft. of grate area and 4000 sq. ft. of heating surface. Each contains 192 tubes 4 in. in diameter and 20 ft. long, and 2 steam drums 42 in. in diameter and 20 ft. long. The boilers are designed for a pressure of 150 lb., the 4-in. pop safety valves being set at that point. In addition to this equipment 2 new 500-hp. boilers of the same type have been installed with grate areas of 90 sq. ft. and heating surfaces of 5087 sq. ft., which consist of 252 4-in. tubes 20 ft. long and 2 42-in. steam drums 20.5 ft. long, the 4.5-in. pop safety valves being set at 160 lb. Both boilers have ⅝-in. steel heads and 7/16-in. shells. The working pressure is 135 lb.

All boilers are equipped with 12-in. steam gages reading to 300 lb., water columns fitted with try cocks and shutoff devices for renewing gage glass, Vulcan soot blowers, and Babcock & Wilcox chain grate stokers.

Complete apparatus for making boiler tests,—consisting of water weighing tanks with water meter, recording draft gages, flue gas thermometers, Havard coal meters and CO_2 apparatus,—is provided, as well as special pipe connections to each boiler which are shown along the foot of the boilers in Fig. 6. Damper control is secured by means of a McDonough damper regulator, while a complete record of the kind of smoke and the duration of smoking is registered by a Hamler-Eddy smoke recorder located in the boiler room.

Handling of Fuel and Ash

COAL is delivered from the car, on a spur track running past the boiler house, through a chute leading into the basement, where it enters the coal crusher and is crushed to the size desired and then fed into a Link Belt conveyor which elevates it to the top of the boiler house into reinforced concrete coal bunkers, each of 100 to 150 tons capacity. From these bunkers it is fed to the stokers through the steel spouts visible in Fig. 6. All steel parts of the coal pockets and spouts are treated with a special enamel to prevent corrosion. The ashes are taken out by means of the same conveyor which runs directly beneath the ash hoppers in the basement and from there are conveyed to an ash bin overhead from which they may be spouted into a car.

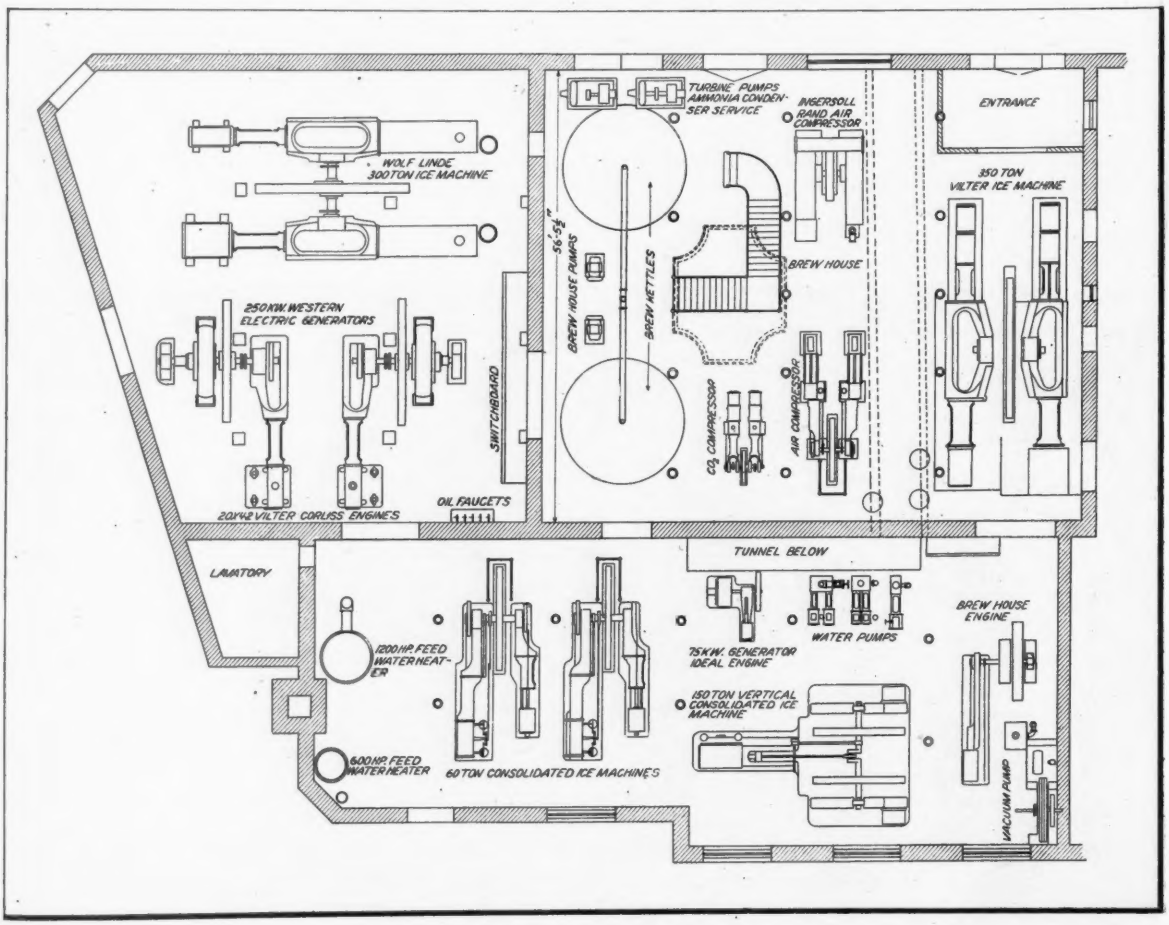


FIG. 2. GENERAL PLAN OF ENGINE ROOM

Engines

ELECTRIC power transmission is used throughout the plant, the current being generated by 2 20 by 42 in. Vilter-Corliss engines direct connected to 2 Western Electric generators, each of 250 kw. capacity and running at 100 r.p.m. These generating units are run at an average overload of 500 amp., the rated load being 2000 amp. and the average load on the plant about 2500 amp. As a reserve unit there is a 75-kw. Siemens & Halske high speed generator direct connected to an Ideal engine.

Direct current is delivered for lighting and power on a 110-volt system. The switchboard consists of 7 panels and is wired so that each department may be shut off separately, wattmeters being provided on each main feed line. It is also provided with Weston ammeters and voltmeters, Bristol recording ammeter and voltmeter and Thompson integrating wattmeter which registers the total current produced. Both tungsten and carbon-filament lights are used on the lighting circuit.

Refrigerating Equipment

REFRIGERATING machinery employed for cooling the beer and maintaining a low temperature in the large storage cellars includes 1 Wolf-Linde 300-ton ice machine with 18 by 42-in. ammonia cylinder driven by a 22 and 44-in. Allis-Chalmers cross-compound condensing engine, with 42-in. stroke, 2 Consolidated ice machines of 60 ton capacity each and a 150-ton vertical Consolidated ice machine, the last 3 being driven by simple Corliss engines running noncondensing.

walls. The cylinder heads are turned to conform to the shape of the pistons, resulting in small clearance spaces, a large valve area, and permitting the use of multiple suction and discharge valves in each cylinder head.

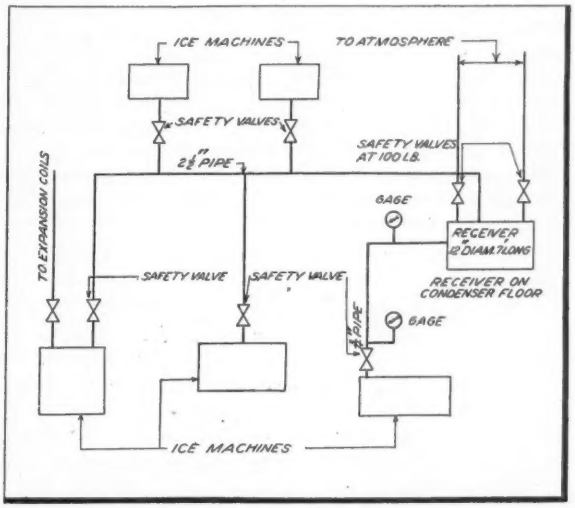


FIG. 4. SKETCH OF AMMONIA SAFETY VALVE ARRANGEMENT

The cellars which contain a total volume of 2,218,000 cu. ft. are cooled by the direct expansion ammonia system, containing 7 ammonia receivers, 40-in. diameter and 8 ft. long, and throughout the year are kept

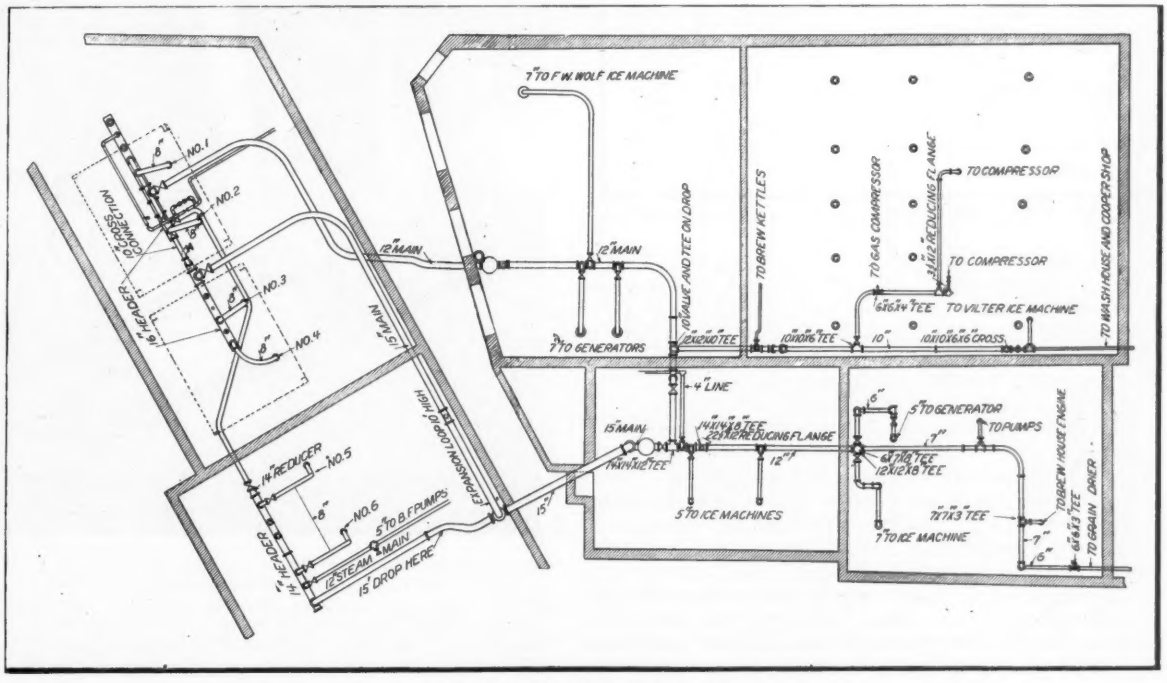


FIG. 3. PLAN OF HIGH PRESSURE STEAM PIPING

Also of recent installation is a Vilter ice machine with 90 by 38-in. ammonia cylinder and of 350 tons capacity, operated by a 28 by 52-in. cross-compound condensing Vilter-Corliss engine with 38-in. stroke. The cylinder and piston of this machine are of noteworthy construction, the piston having spherical ends, thus presenting a large bearing surface to the cylinder at a temperature varying from 32 to 38 deg. F. The pressure carried varies from 150 to 175 lb. For cooling the beer in the fermenting tanks special brine coils are installed, the apparatus consisting of a 50-ton brine tank with submerged coils and a double pipe brine cooler of 8 sections working under the flooded system, the brine being circulated by 2 electric driven 2-stage

Worthington and American Well Works brine circulating pumps, pumping 350 gal. per min. against a head of 110 ft. A total of 110,900 ft. of 2-in. ammonia piping is used through the system.

Of notable importance is the ammonia safety valve arrangement by which safety is secured and yet the valve leakage is saved. Fig. 4 shows a sketch of this system. From the ammonia safety valve which is set at 250 lb. on each machine, pipes ranging from 1.25 in. to 2.5 in. lead to a main 2.5-in. pipe which opens into a receiver, 12 in. in diameter and 7 ft. long. Connected to this receiver are 2 more safety valves, set at 100 lb., which are furnished with an outlet to the atmosphere, providing for immediate exhaust to the atmosphere

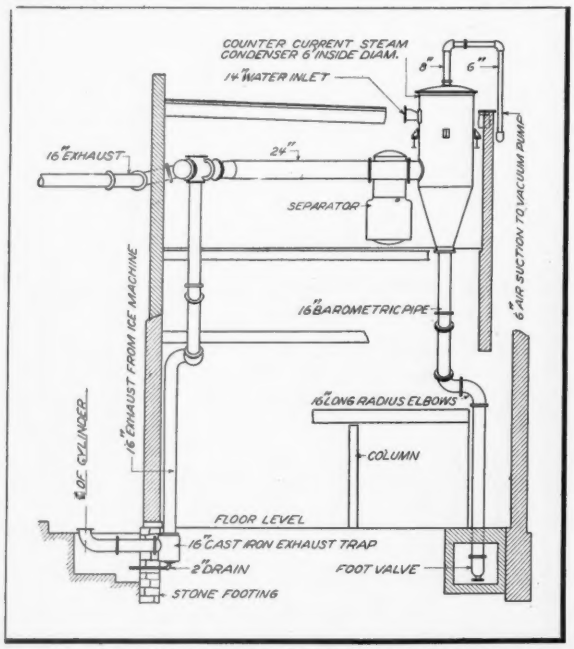


FIG. 5. SECTION OF CENTRAL COUNTER CURRENT STEAM CONDENSER

at any pressure over 250 lb. in the machine. Under normal conditions the ammonia leakage through the safety valves is retained in the receiver and when the gage in the engine room shows a pressure of about 60 lb., this leakage may be drawn back into the system again through a ¾-in. pipe connecting the receiver to one of the machines.

In Fig. 5 is shown a section of the Vilter central counter current condenser in which the exhaust steam from the Vilter and Wolf-Linde ice machines is condensed and returned to the hot well. This condenser is large enough to take care of 26,000 lb. of steam an hour at a vacuum of 27 in. The exhaust is carried away from the machines through 16-in. pipes which unite into a single 24-in. branch which leads through a separator and enters near the top of the condenser. Within the shell of the condenser annular and circular shells are arranged alternately, from which the cooling water falls in a cascade-like manner, meeting and at the same time condensing the ascending exhaust steam, the condensate being carried to the hot well through the 16-in. barometric pipe.

The air and vapors are removed from the top of the condenser by a dry vacuum pump with a balanced valve which is electric driven by a Northern 30-hp. shunt wound motor and controlled automatically by a Cutler-Hammer electric controlling device which regulates the speed of the pump in a relation to the hot well temperature.

Oiling System

LUBRICATION for each machine is provided by means of Nugent oiling devices, while cylinder oil is supplied through Richardson-Phenix and Hills McCanna force feed lubricators. When a barrel of oil is received it is pumped from the engine room to a reservoir overhead which is divided into several compartments, for the various grades of oil. From this reservoir the oil is then fed by gravity to the copper drawstand in the engine room where the faucets are labeled; filtered, liquid base, dynamo, ice machine, machine or cylinder oils may be drawn from this central supply.

Water Supply

WATER for the ammonia and steam condensers is pumped from the river by an American Well Works centrifugal sump pump, while that for washing and soaking is pumped from 3 artesian wells 1600 ft. deep by air lifts working under 100 lb. pressure and pumping 400 gal. a minute. Now being installed at one of these wells is an 8-stage turbine pump built by

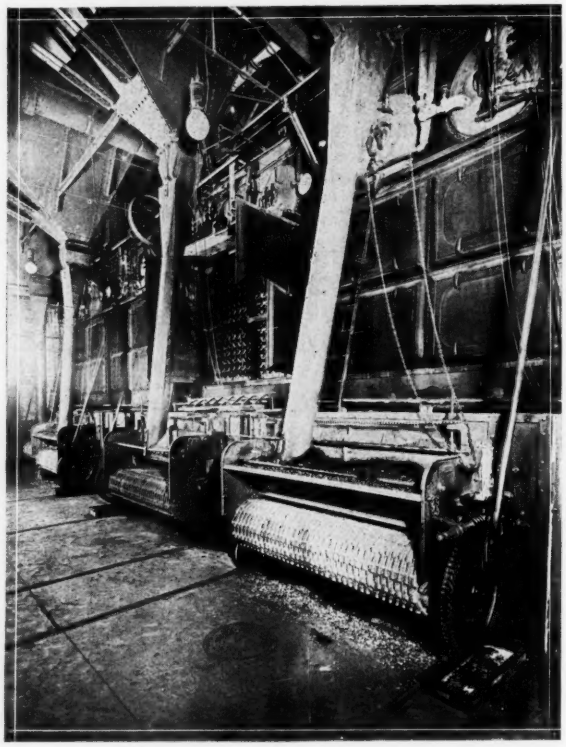


FIG. 6. VIEW IN OLD BOILER ROOM SHOWING BOILER FRONTS AND CHAIN GRATE STOKERS

the American Well Works which is expected to deliver 600 gal. per minute. City water is used for boiler feed and the heating system circulation. Two 14 by 8½ by 12-in. Snow outside packed, duplex boiler feed pumps supply water for the boilers. These pumps are located in the new boiler room and enclosed in a separate house. The feed water is first used as cooling water in the beer coolers which it enters at the prevailing lake water temperature and leaves at a temperature of about 120 deg. F. From the coolers it is put through the exhaust heaters, and pumped to the boilers through a 5-in. main feed line, shown in Fig. 3, entering the

different boilers through branch 2.5-in. lines on each of which is located an asbestos plug cock, globe valve, cross with thermometer socket and gate valve, swing check valve and stop gate valve. The temperature upon reaching the boiler is about 210 deg. F. The valves on the new boilers are of Hancock make and those on the old boilers of both Crane and Jenkins manufacture.

Feed-water heaters are of the closed type, the larger being of 1200 hp. 6 ft. in diameter and 18 ft. 8.5 in. long with tubes 14 ft. long and containing 1200 sq. ft. of heating surface. The smaller is of similar construction, 4 ft. diameter and 18 ft. long, with a rating of 600 hp.

Heating System

FOR heating the plant the Evans-Almirall forced circulation hot water heating system is used, the water being forced through the circuit by an electric driven De Laval 7½-hp. centrifugal pump. Upon leaving the pump it passes through the exhaust heaters and then through the radiators or coils, as conditions demand, the returns of which are merged into one pipe which connects to the suction end of the pump, the same water being used continuously.

Steam Piping and Drainage

FIGURE 3 shows the general arrangement of the steam piping in which all piping is of full weight, fitted with Crane weld joints and insulated with 85 per cent magnesia covering. Starting at boilers 1, 2, 3, and 4 the steam is carried through 8-in. leads in long radius bends to 2 16-in. headers with 10-in. cross connections. From these headers there is a 10-in. cross over to the 14-in. header over boilers 5 and 6 from which the steam travels through 8-in. boiler leads.

Running from these headers are 2 12-in. steam mains, one of which goes directly to the engine room while the other joins with a 15-in. main header leading to the engine room. Both mains pass through separators immediately inside the engine room and then extend in parallel down through the building, supplying the engines, pumps, brew kettles, wash house and drain driers. By this arrangement, any combination of boilers may be run together and the steam conveyed to the engine room through either or both of the mains.

From each boiler is a 2.5-in. blowoff connection, equipped with Homestead blowoff valves, leading to a 4-in. main line which extends to the basement and enters the blowoff basin near the top. The outlet pipe to the sewer extends up from the bottom of the basin, leaving near the top, while from the top of the receiver a 12-in. vent pipe extends to the roof, thus furnishing a large outlet for the steam and preventing it from entering the sewer.

COMBUSTION OF COAL*

In Relation to Steam Boiler Economy

By E. A. Uehling

EVERY pound of coal of a given composition contains a definite amount of potential energy. Combustion liberates this potential energy in the form of heat energy. To produce combustion 2 factors are necessary: (a) oxygen, (b) high temperature.

Coal exposed to oxygen at atmospheric temperature remains unaltered both physically and chemically, and hence retains its potential energy practically unaltered. Coal exposed to high temperature under conditions that exclude oxygen is decomposed, i. e., it becomes physically and chemically changed, but its potential energy is practically unaffected. Its volatile constituents are driven off in the form of vapor and gas; the solid constituents, consisting of fixed carbon and ash, remain in the form of coke. The volatile combustible constituents consist of hydrogen and a great variety of combinations of hydrogen and carbon (hydrocarbons.) But if coal is exposed to oxygen at a high temperature combustion takes place.

Combustion in the narrow sense here under consideration is the chemical reaction between oxygen (O) and carbon (C) forming carbon dioxide (CO_2), and between hydrogen (H) and oxygen forming water vapor, i. e., steam (H_2O).

This chemical reaction, called combustion, liberates the potential energy in the form of heat energy. For every unit of carbon and every unit of hydrogen, a fixed quantity of heat energy is liberated. This heat energy becomes effective at once by heating the solid carbon and ash of the coal to incandescence and raising the gaseous products of combustion to a high temperature, called the flame temperature. The highest flame temperature results from complete combustion with the theoretically correct quantity of oxygen. In practice theoretically perfect combustion is impossible, but complete combustion is attainable, and, to produce the greatest useful heat effect, should be accomplished with a minimum excess of oxygen, as will be shown further on.

Rapidity of combustion depends on the temperature of the fire, and the quantity of oxygen supplied. The total heat energy liberated per pound of a given coal, however, is independent of the rapidity of combustion, provided combustion is complete.

The oxygen required for the combustion is derived from the atmosphere. Atmospheric air is composed of a mixture of 23 parts oxygen and 77 parts nitrogen by weight. Nitrogen retards combustion and absorbs heat, hence reduces the flame temperature, but in as far as combustion with pure oxygen would produce a flame temperature far beyond the endurance of any material available for furnace construction, nitrogen serves a useful purpose in reducing the flame temperature to within practicable limits.

On the other hand, we have seen that high temperature is necessary to induce combustion, hence too great an excess of oxygen with its accompanying fourfold quantity of nitrogen will tend to bring the flame temperature below the point of ignition.

In the burning of coal, decomposition always precedes combustion; hence the greater the amount of volatile combustible contained in a coal the greater

*A paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers. Semi-Annual Convention at Pittsburgh, Pa., May 16, 17 and 18, 1912.

the flame volume, and the greater the length of flame the greater the loss of heat from radiation and the probability of incomplete combustion because of low flame temperature.

Smoke is the usual manifestation of incomplete combustion. It results from 3 causes: low flame temperature; stratification of air and the volatile combustible gases; deficiency of oxygen, i. e., an insufficient supply of air. In boiler practice, to which these remarks are chiefly directed, the latter is of rare occurrence. Stratification is caused by incompetent or careless firing, leaving an uneven fuel bed. The air following the course of least resistance rushes through the light covering in excess of requirement and in inadequate quantity through the heavier portions, resulting in strata with oxygen in great excess and strata with deficiency of oxygen, all below the temperature which would result from proper intermingling of the air with the combustible gases, the one because of a deficiency in combustible, and the other because of a lack of oxygen, all quickly becoming cooled below the point of ignition by giving up their heat to the boiler before opportunity for combustion was offered by proper intermingling.

It was stated above that decomposition precedes combustion. This is not only true for the coal itself, but also for the hydrocarbons. Heat separates the heavy hydrocarbons into free carbon and light hydrocarbons, and before combustion can take place the latter are further separated into carbon and hydrogen. In the act of combustion 2 atoms of hydrogen combine with one atom of oxygen, forming H_2O, water vapor, and one atom of carbon combines with 2 atoms of oxygen, forming CO_2, carbon dioxide.

Combustion of the hydrogen precedes that of the carbon and liberates an intense heat which raises the temperature of the carbon to incandescence, producing a luminous flame. Under certain conditions such as prevail in a Bunsen burner where the air and gas are very intimately mixed before ignition, both reactions take place simultaneously and a non-luminous flame results.

If the gas is mixed with air in the proper proportion a very hot non-luminous flame is obtained; if the air mixed with the gas is insufficient for complete combustion and the deficiency is supplied from the surrounding air, partial luminosity results; if the air supply is all from the outside, then under favorable conditions, such as are met in burning illuminating gas in a good fish-tail burner, complete cumbustion is obtained with full luminosity; but if conditions are such that the air cannot get to the gas promptly, as, for example, when gas issues from a round orifice of considerable size, a smoky flame results. Heavy hydrocarbons, such as contain a high percentage of carbon, are more liable to burn with a smoky flame than light hydrocarbons.

If a luminous flame is brought in contact with a cold body, smoke and soot invariably result. The same result takes place if the flame temperature is reduced from any other cause, such as rapid radiation or admixture of an excess of cold air. Too great an excess of air is a prolific source of incomplete combustion. If too great an excess of air be mixed with the gas in a Bunsen burner, combustion will cease, because the heat absorbed by this air reduces the flame temperature below that required for ignition.

Carbon has 2 stages of combustion, the first $C+O=CO$, the second $CO+O=CO_2$. The first stage liberates 4451, the second 10093, and the complete combustion of carbon yields 14544 B.t.u. per unit of carbon. Therefore, to get the highest heat effect from the carbon, every atom of this element must combine with 2 atoms of oxygen. But CO_2 is unstable in the presence of incandescent carbon, to which it readily gives up one atom of its oxygen, forming 2 molecules of CO. The reaction $CO_2+C=2CO$ is an endothermic reaction, heat absorbing, hence lowers the flame temperature. H_2O is also unstable in the presence of incandenscent carbon and the reaction $H_2O+C=CO+2H$; this reaction is also endothermic, and a flame initially low in temperature or the temperature of which has been lowered by radiation, may be and frequently is, cooled down by these reactions below that required for re-ignition, so that CO and H together with more or less of the light hydrocarbons will pass off unconsumed with the smoke, which will always be ample under these conditions, even though an excess of oxygen may have been present. A large excess of air may even assist, as we have endeavored to show, to bring about the above unfavorable condition for complete combustion. Therefore, to secure complete combustion we must have, first, a hot furnace; second, a moderate excess of air; third, thorough intermingling of the air with the volatile combustibles. The first implies proper furnace construction, which means that the furnace must be so constructed that combustion will be complete before the temperature of the flame is materially reduced; the second, that the air supply must be controlled so as to avoid too great an excess; and the third, that the firing must be judiciously and skillfully done and the air admitted in the proper manner.

The object of burning coal under a steam boiler is to convert the chemical potential energy contained in the coal into mechanical potential energy, in the form of steam under pressure. Heat is the medium of transfer and the problem before the combustion engineer is, first, how to burn the coal completely, and second, how to get the maximum amount of heat liberated by combustion into the water and steam contained in boiler under which the coal is burned.

This problem can only be solved in a practical way, but the practical man cannot arrive at the proper solution unless he allows himself to be guided by the light of theory. Science and practice must join hands; scientific refinement may be of questionable value, but scientific aids, in the form of indicating and recording instruments, are necessary, and scientific reasoning is absolutely essential.

We have stated at the outset that the total heat energy liberated per pound of a given coal is independent of the rapidity of combustion, provided combustion is complete. To carry this idea a little further; assuming complete combustion, the same quantity of heat will be liberated whether combustion takes place under high draft, i. e., very rapidly, or, under a low draft, i. e., slowly, whether the coal is burned with the smallest possible excess of air, or an abnormally large excess, whether the resulting flame temperature reaches the maximum or minimum limits permissible.

To convert all the chemical potential energy contained in the coal into heat energy is the object of combustion, to convert this heat energy into physical potential energy, in the form of steam under pressure, is the object of burning the coal under the boiler.

The first part of the problem is, therefore, to secure complete combustion, the second part to get the maximum amount of heat energy liberated into the water contained in the boiler.

It has been experimentally demonstrated that the greater the difference of temperature between 2 bodies the more rapid will be the transfer of heat from the hot to the colder body, hence the hotter the fire the more favorable the condition for getting the maximum amount of heat liberated into the water contained in the boiler. It follows from this that for the same rate of combustion per square foot of grate area the smaller the excess of air the lower will be the chimney temperature.

The greatest item of loss is due to the heat carried out through the chimney by the products of combustion, the flue gases. This loss increases as the difference in temperature between the flame and the flue gases decreases, and increases directly as the weight and temperature of these gases increase; now since the weight of the flue gas per unit of combustible increases directly with the excess of air supplied, and since the temperature of the flame is decreased thereby and that of the flue gas is increased, the importance of regulating the air supply becomes evident.

It is practically impossible to attain complete combustion of coal with the theoretical amount of air required to oxidize fully all its combustible elements. The amount of air required for maximum economy will vary with the chemical nature and the physical condition of the coal, with the type and construction of furnace and boiler, the availability and regulation of the draft and the manner of stoking; but for any one of these or combination of these conditions, there is a minimum excess of air that will produce maximum economy. Every pound of air in excess of that required carries heat to waste and a very great excess may even be the cause of incomplete combustion, thus proving wasteful at both ends.

We have endeavored in the preceding line of reasoning to establish as clearly as possible the fact that any excess of air beyond that required for complete combustion necessarily results in a loss of heat and hence reduced economy.

Since every pound of combustible contained in a given coal carries a definite per cent of carbon, it follows that in complete combustion with the theoretically required amount of air, the products of combustion must contain a definite per cent of CO_2. It further follows that the per cent of CO_2 must decrease as the excess of air increases and that CO_2 is, therefore, a correct index of the loss of sensible heat up the chimney.

Sporadic determinations of CO_2 are of small value, and unless judiciously taken, may even be quite misleading. The CO_2 from an average sample collected uniformily over a day's run is more valuable, since it shows the average efficiency of the fire, and in connection with the factor of evaporation will be of great aid in determining the conditions for improving economy; but here again the results may be misleading, especially in connection with hand-fired boilers. A proper per cent of CO_2 in an average sample spread over a day's run is no guarantee of regular and efficient stoking. At some intervals the CO_2 may have been too high and at others too low for efficient work, causing a loss of combustibles due to deficiency of oxygen during the former, and a loss of sensible heat due to too great an excess of air during the latter intervals. These uncertainties are all eliminated by employing an apparatus which will continuously indicate and autographically record the per cent of CO_2 contained in the flue gases. Such a record is not only of the greatest assistance in determining the excess of air required for maximum efficiency, but it is necessary also to be able to maintain the high efficiency which it has been possible to attain by intelligent application of theory and practice to the existing conditions.

Progressive engineers as well as combustion experts have for some time been fully aware of the fact that continuous indication of the per cent of CO_2 would be of the greatest value as a guide to the fireman, enabling him to keep his fires at the highest point of efficiency, and that a continuous record of the CO_2 and temperature of the flue gas would place before the engineer in charge the information necessary to control his firemen and maintain his boilers in a condition insuring maximum economy.

A CO_2 recorder to be successful must be simple in design, of substantial construction, and reliable in its operation. It should be easy to keep in order and require only moderate amount of attention. It must operate at a distance, so that it can be placed away from the smudge and dirt of the boiler room. It must indicate the per cent of CO_2 at or near the boiler front for the fireman, and make a continuous record for the engineer or superintendent in charge. It must be properly installed. So much for the instrument itself. But that is not all. To insure success and get results a few more things are required. The instrument must receive proper attention; the clocks must be wound, the records must be changed, the caustic must be replenished, the gas filters renovated and the sampling tube kept clear. It should not take over 15 to 30 minutes a day per unit to do these things, but it must be somebody's business to do it. And to be sure that it will be done, somebody's job must depend on keeping the CO_2 recorder in running order, just as somebody's job depends on keeping the pumps or dynamos or any other piece of machinery in order. And last but not least, the records must be scrutinized and interpreted, and action taken accordingly. Results will then surely follow.

It is our opinoin that it is only a question of time when it will be considered just as essential to equip a boiler plant with CO_2 recorders as with feed-water heaters. It will only be a question of choosing the best apparatus for the purpose.

THE AMOUNT OF COAL mined in Texas in 1911 was the greatest in the history of the industry in the State, according to Edward W. Parker, of the United States Geological Survey, in a statement just made public. The production was 1,974,593 short tons, valued at $3,273,388, an increase over 1910 of 82,417 tons and $112,323. Texas produces both bituminous and lignite coals. In 1911 both the greater production and the greater increase were in bituminous coal—1,038,592 and 73,008 tons, respectively. Bituminous coal was produced in 7 counties and lignite in 12 counties. The average price of bituminous coal was $2.30 and of lignite 88 cents a ton.

The increased production of coal and lignite in Texas in 1911, as in 1910, may be attributed to the growing population and industrial development of the State, which consumes not only its own product, but also considerable quantities brought in from Arkansas and Oklahoma on the north and Colorado and New Mexico on the northwest. It also produces and consumes large quantities of fuel oil. It is estimated by David T. Day, the Geological Survey's petroleum statistician, that the consumption of fuel oil in Texas in 1911 was 6,500,000 barrels.

DETAILS OF POWER PLANT DESIGN

Rules to be Followed in Exhaust Piping, Draining Pipe Systems, Feed Piping and Insulation

By Chas. L. Hubbard

EXHAUST piping will vary somewhat in different cases depending upon whether the plant is to be run condensing or noncondensing, and also upon the disposal of the exhaust steam in noncondensing plants. When there is a sub-basement under the engine room the exhaust piping may be carried in this space, otherwise it is best run in covered trenches beneath the floor. When the exhaust in used for heating, the main pipe should branch, one leading to the heating main and the other outboard through a back-pressure valve. The connections with the feed-water heater in a noncondensing plant will vary with the type of heater used. In some cases the whole volume of steam is passed through the heater, while in others only sufficient to do the work, the remainder flowing outboard through a by-pass. In the case of exhaust heating systems frequently a single connection is made with the heater, called the "induction"

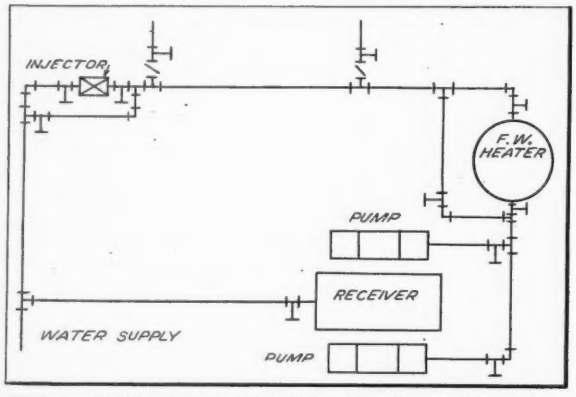


FIG. 1. ARRANGEMENT OF PIPING AND AUXILIARIES FOR NONCONDENSING PLANT

system. In a condensing system 2 heaters are commonly used. The primary heater is filled with steam at condenser pressure, and therefore below that of the atmosphere, and must consequently be drained by means of a vacuum pump, return trap, or special form of drainage tank.

Exhaust from the pumps and other auxiliaries which are operated noncondensing is turned into a secondary heater, which may be drained through an ordinary trap. The feed water is first passed through the primary heater and then the secondary on its way to the boilers.

Drainage

THE matter of drainage is one of great importance, and ranks with that of flexibility. Steam mains should always, if possible, be so graded that the steam and water will flow in the same direction under normal conditions. If this is not possible the pipes should be a size larger than would otherwise be called for. Pockets and low points should be avoided, but if for any reason local conditions require them, they should be drained through reliable traps where the pipe rises again. When mains of considerable size are carried for long distances they should be dripped every 100 ft., or so, into a line carried back and trapped into the receiving tank in the boiler room. If the main header is divided into sections, each should have its separate drip. Care should always be taken in placing both globe and gate valves in such a manner that pockets will not be formed for the accumulation of condensation. The former ought never to be used in horizontal pipes with the stem in a vertical position, nor the latter with the stem in a vertical position and the wheel at the lower end. When the throttle of an engine or pump is placed at the bottom of a vertical supply pipe, the pocket which is formed should be dripped by means of a bleeder connected into the pipe just above the valve, or into the body of the valve itself above the gate. This may be blown out by hand just before starting, or better, in the case of elevator pumps and engines which run intermittently, drained automatically by means of a trap.

Condensation from lines containing no oil is usually trapped into a vented receiver and pumped back to the boilers.

Drips from oil separators, feed-water heaters, and all other parts of the exhaust system containing oil are trapped to the sewer or sump well. Cylinder cocks are commonly connected with the blow-off tank which allows the steam to pass off through the vapor pipe.

Feed Piping

BEST ways of connecting up the feed piping will depend upon the type of system and the apparatus in use. The following diagrams will show in a general way the conditions to be met in the more usual cases.

The arrangement for a noncondensing plant is shown in Fig. 1. The pipe from the city main or other source of supply branches as shown, one leading to the receiving tank and the other to an injector near the front of the boilers. The branch leading to the tank may have either a hand valve for regulating the supply of water or may be supplied with a ball cock for admitting it automatically as needed. The discharge from the pump is forced through a feed-water heater, a by-pass being provided for use when the heater is out of commission. Sometimes the injector is placed on a separate line in large plants, so any boiler may be emptied and refilled independently of those under steam pressure.

A layout for a condensing plant is shown in Fig. 2, a jet condenser being used discharging into the sewer. The only difference in this case is the addition of a primary heater placed in the main exhaust pipe between the engine and condenser.

A condensing plant with a surface condenser is shown in Fig. 3. The exhaust in this instance is first passed through an oil separator, and the discharge water from the air-pump turned into the hot well from which it is pumped back to the boilers.

A feed-water heater taking exhaust steam from the auxiliaries is used as indicated. The fresh water supply, high-pressure drips, and return from the heating system are, in this case, discharged into a hot well instead of a receiving tank. The pump suction is so valved that it can take its supply either from the main or hot well.

Pipe Sizes

IT is common practice in power plant work where the piping is fairly compact to base the sizes on the velocity of flow. The maximum usually allowed is 6000 ft. per minute for high-pressure mains and 4000 ft. for the exhaust. These velocities may serve as a guide, but in practice it is customary to make the pipes slightly larger.

A simple method often used is to allow 0.12 in. area per indicated horsepower for the supply pipe to modern high speed engines and 0.18 sq. in. for the exhaust. The factor 0.12 may also be applied to boilers with good results, as 30 lb. of steam per indicated horsepower per hour at 70 lb. pressure represents the average water-rate of simple noncondensing engines as well as the quantity furnished by one boiler horsepower.

The following rules are often used, although they give a slightly smaller pipe than the factors noted above.

Multiply the length of stroke by the revolutions per minute, divide the product by 36,000 and extract the square root, then multiply this root by the diameter of the engine cylinder and the result will be the diameter required for steam pipe. The diameter of the exhaust pipe is found by the same rule except that the constant is 24,000 instead of 36,000.*

A method sometimes employed with good results is to provide a separator at each engine, having a cubic capacity about 3 times that of the high-pressure cylinder, and placed close to it. The connection between the separator and cylinder is then made the full size called for by the engine builders, while the connection with the supply main is made 1 or 2 sizes smaller. The object of this arrangement is to have a full supply of steam close to the throttle; to provide a cushion near the engine on which the blow caused by the cutoff may be expended, thus reducing the vibration transmitted to the piping system; and finally to produce a steady and rapid flow of steam in one direction.

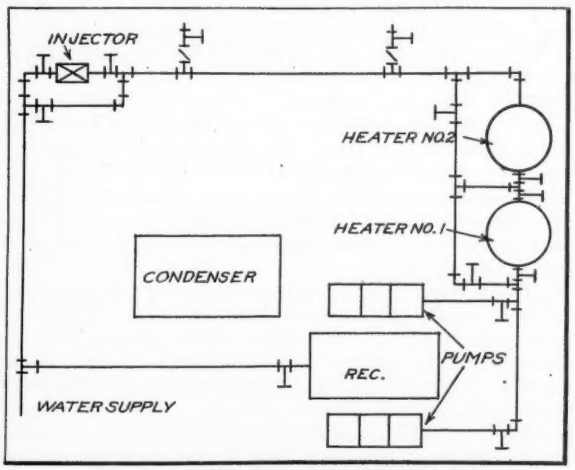


FIG. 2. LAYOUT FOR CONDENSING PLANT

The size of the feed pipe is usually determined by the outlet from the pump. Special makes of boilers, feed-water heaters, etc., have the size of feed connections fixed, so that in piping up the various pieces of apparatus it becomes simply a matter of proportioning the pipes to the openings to be connected.

When tubular boilers are used the size of feed pipe is usually fixed by the designing engineer. This is commonly based on the diameter of the boiler, and the data given below will be found useful in this connection.

Dia. of Boiler.	Dia. of Feed Pipe.
42 inches	1 inch
48 inches	1 inch
54 inches	1¼ inch
60 inches	1¼ inch
66 inches	1½ inch
72 inches	1½ inch

Although it is quite common practice to make the sectional area of the main and branches equal, the total area of the branches should be somewhat larger than the main, owing to the greater friction.

Insulation

STEAM pipes, separators, heaters, etc., should be covered with some good form of insulation to reduce the amount of condensation and to prevent, to some extent, overheating the engine and boiler rooms.

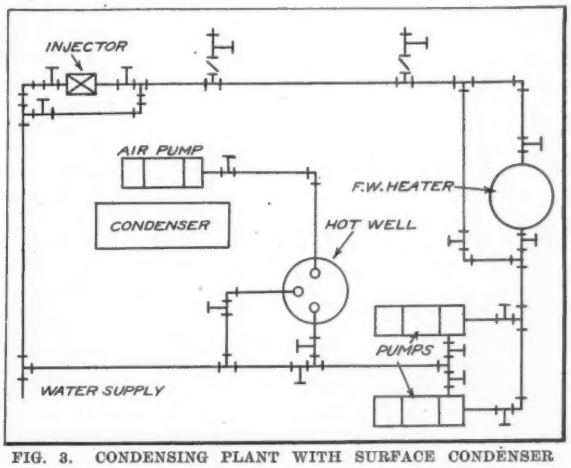


FIG. 3. CONDENSING PLANT WITH SURFACE CONDENSER

Sectional covering is used almost exclusively on piping up to 12 in., or so in diameter, and block covering with a special canvas jacket on larger sizes.

Heaters, tanks, etc., are insulated with both block and plastic covering, or a combination of the two.

In selecting a covering, its durability should be considered of equal importance with its nonconducting properties. Many coverings will show a good efficiency when new, but deteriorate quite rapidly when placed upon a pipe line connected with high-speed engines or other machinery causing vibration. Insulating material containing corrosive substances such as plaster of Paris and sulphur should always be avoided. Carbonate of lime, or common chalk does no harm, but is reduced to a powder by vibration and thus becomes useless for insulating purposes. Some inferior grades of mineral wool contain sulphur which is likely to attack the pipe if it becomes moist.

Carbonate of magnesia and asbestos fiber both make an efficient and durable covering when properly made, and the words carbonate and fiber should always be mentioned when specifying these materials.

*Expressed as a formula this becomes:

$$(1)\ d = D\sqrt{\frac{LxR}{36{,}000}}\ \text{for steam pipe}$$

$$(2)\ d = D\sqrt{\frac{LxR}{24{,}000}}\ \text{for exhaust-pipe in which,}$$

d = diameter of pipe in inches.
D = diameter of engine cylinder in inches.
L = length of stroke in feet.
R = revolutions per minute.

Cork makes a good covering when properly prepared, and is especially adapted to places where it is likely to be exposed to moisture.

The heat loss from bare pipes varies from 2.5 to 3 thermal units per hour per square foot of surface per degree difference in temperature between the steam and surrounding air, depending upon the size of pipe and circulation of air around it. Tests show that from 75 to 85 per cent of the heat lost from bare pipes may be saved by the use of a good covering. Taking the average as 80 per cent, and assuming a loss of 3 thermal units as above, the saving in any particular case may be easily approximated.

ROPES AND ROPE TRANSMISSION

Experiences in a Plant Employing Rope Drive; Some Difficulties Encountered and Suggestions for Their Remedy

By J. O. Benefiel

OCCASIONALLY we come across articles in the technical press on rope transmission, but few of them give information of any great use to the man in actual charge of such apparatus, being mostly from the viewpoint of the designer and consulting engineer. I believe an exchange of experience between engineers on this subject would result in much benefit to all, so will relate my experience covering three years with a transmission system of the continuous type.

There are 5 drives from the engine to the main line shaft from which 4 drives are taken to other lines of shafting, the total amount of rope being 2500 ft. of 4-strand 1⅛ in. in diameter. The power transmitted is 125 hp., the character of the work performed is making small forgings on Bradley and upright hammers. The conditions are not good for either belt or rope drive on account of the heat and injurious effect of the products of combustion soon taking the life out of either one. A piece of new rope laid away overhead will lose most of its strength in a year.

Wear seems to us to be excessive on the part of the strands that come into contact with the grooves, making it impossible to maintain a good, smooth splice. It always cuts the feathers to shut down the room or a group of machines long enough to make a splice, or if the tension carriage is not well run out it would be better for us if we had a greater travel, so we could always have slack enough to make a splice, but sometimes it is impossible to arrange it this way.

It takes us at least an hr. to make the splice generally used, and 1½ to 2 hr. to make the splice recommended by the Dodge Company. It is impossible, at least for us, to make this splice on a worn rope because the yarns come apart when separated from each other. A rope usually gives out by one strand coming loose and we are now, whenever possible, unwinding this broken strand back for some distance and replacing it with a good strand, tucking the ends the same as in making a splice; this takes at most not over a half hr. and if carefully done the new strand will outlast the rest of the splice. One fault we have with a rope drive is that we do not know when it is going to give out until we see the ends of a strand whipping around.

We think one cause of the rapid wear of these ropes is the steel scale, dust and grit that is in the air, getting on the ropes and in grooves and setting up a grinding action. We use a rope grease recommended by the company who installed the outfit, but do not believe it does much good under our conditions; possibly a rope that had been treated with some preparation while in the process of manufacture would give better results. In its favor it can be said it never slips and the cost of ropes, even with the present rate of wear, will be less than that of belts, and belt drives in this department do not give satisfaction because of the heat quickly taking the life out of them and no matter if the tension is properly adjusted during the day, at night they absorb moisture and stretch until they are loose enough to slip in the morning, until the moisture is driven out again.

It is our opinion that the power transmitting capacity of these ropes is rather overrated as we improved conditions on one drive by replacing the 1⅛ in. with a 1¼ in. rope. The sheaves are 60 in. in diameter, which, according to all rules, is ample size. We have found that the shafting where a rope drive is used must be supported more rigidly than with belting, as we had quite a number of broken shafts in places where we changed from belting to rope. While we have no data on the subject, it seems to us that the friction loss should be greater with rope than belt.

IMMENSE STEAM POWER PLANT PROJECT

Lehigh Navigation Electric Company Place Big Electrical Contract

RECENT execution of a contract by the Lehigh Navigation Electric Company, Philadelphia, Pa., with the General Electric Company, Schenectady, N. Y., for 3 10,000 kva., 11,000 volt, 3-phase, 25-cycle, complete horizontal turbo-generating units with 2 300 kw. turbo-exciter sets and one 300 kw. motor-generator exciter set, to be installed in its new main generating station at Hauto, Carbon Co., Pa., is significant of the progress of active constructive operations in the inauguration of the largest electrification project since the establishment of the Niagara Falls power plants.

Preliminary reports of this proposed gigantic undertaking appeared in the technical and general press the fore part of last year; although a comprehensive scientific investigation of the commercial and engineering feasibility of the undertaking has been in process under the direction of Mr. W. A. Lathrop, president of the company, and Mr. Lewis B. Stillwell, consulting engineer, 100 Broadway, New York, since its inception in 1908.

Aside from the size of this work for the centralization of power generation and distribution, which contemplates an initial expenditure of $3,000,000 and definite plans for an eventual investment of $10,000,000, with an assured supply capacity of 20,000 kw. from the first installation of the 3 10,000 kw. turbo-generators and a gradual enlargement to 100,000 kw. ultimate capacity, it represents the beginning of the most novel and important step toward the economic use of coal and the economic generation of electrical power on a tremendous scale by the means of fuel that has ever been taken in the United States.

Hauto, the site of the central generating station, is located about ten miles west of Mauch Chunk and is at the mouth of a railroad tunnel leading from the main body of anthracite coal owned by the Lehigh Coal & Navigation Company at Lansford. From here the distribution of current for heat, light and power by means of high voltage transmission lines, reaching out

through all Eastern Pennsylvania and New Jersey, will penetrate a territory with 2,500,000 population.

By transforming the effective force of coal into electric energy at the mines and transmitting this direct to consumers and industries, one of the biggest factors, the handling of it—loading, hauling over railroads and dumping—that enter into the cost of coal, will be eliminated. The company figures that still another economic saving will be realized. At present, it has a waste product of about 500,000 tons of coal a year. This consists of coal particles and dust which pass through 3/32 in. mesh screens. All this culm is entirely unmarketable and will be handled so as to be burned in the company's boilers.

The location of the main generating plant at Hauto was also determined because of an abundant water supply. An existing reservoir is being increased to a storage capacity of 1,000,000,000 gal. and an area of about 400 acres by the construction of a higher dam. The water supply needs of the ultimate plant will be some 300,000,000 gal. a day, most of which will be carried back into the reservoirs after condensation. To run the plant up to the contemplated maximum installation of 100,000 kw. capacity, it is estimated that 1,000,000 tons of coal a year will be needed, a quantity of anthracite which would require 20,000 of the largest cars to transport to market.

Among the first power consumers in the district, it is planned to supply the slate and cement industries in Lehigh and Northampton counties, all of which are in a territory from 20 to 40 miles distant from the Hauto plant. Substations will probably be established at once at Coplay and Pen Argyl for stepping down and distributing the current to users. Within a radius of 50 to 75 miles from the main station there are some 20 large cement mills. The transmission lines will be strung largely along the Lehigh Navigation Canal and on the right of way of the Lehigh & New England Railroad, which the company controls.

With the assistance of these companies a complete power census of the industries has been taken, and within the district which will be reached by the distribution system of the first section of the Hauto plant, over 100,000 hp. is being used now. The Lehigh Navigation Electric Company has made up a schedule of prices, running from 8 mills up to some 2½ cents per kw. hr. according to the amount of power contracted for and the steady continuance of consumption, which will deliver its current quite materially under the cost at which the industries are able to produce steam power.

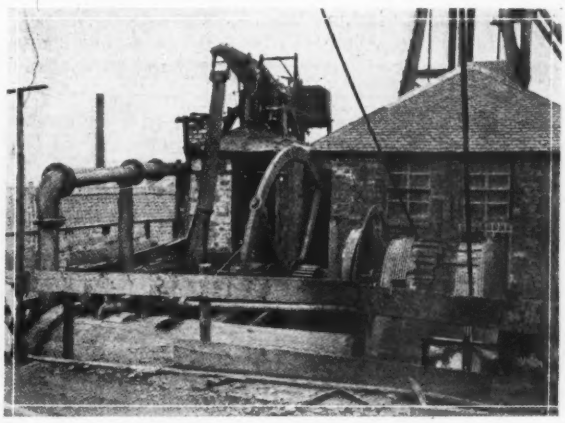
Under the laws of Pennsylvania the right of an electric power company operating with steam to distribute energy is confined to a single township: accordingly, charters have been obtained in Lehigh, Schuylkill, Carbon, Northampton, Bucks and Montgomery counties for about 60 electric companies. The first electric companies organized for each township are in Lehigh County, and consist of the Hazard Electric Company for Hanover, Oakdale Electric Company for Salisbury, the South Whitehall Electric Company for South Whitehall, the Equitable Electric Company for Whitehall, the North Whitehall Electric Company for North Whitehall, the Diamond Electric Company for Washington, the Upper Macungie Electric Company for Upper Macungie, and the Upper Milford Electric Company for Upper Milford. All subsidiary companies will be consolidated under the management of the Lehigh Navigation Electric Company.

With the exception of the 8000 kw. plant of the Harwood Electric Company, which supplies current for lighting and electric railway operation around Hazelton, using coal direct from its own mines, no attempt has been made heretofore in this country to generate electric current in the coal regions for public service. The Lehigh Navigation Electric Company expects to have the first installation at the Hauto plant in operation before the end of the year. As the capacity of the plant is gradually increased, energy will be carried to Allentown and Easton, Pa.; Trenton, N. J., and undoubtedly finally into Philadelphia. This city is within 80 miles and New York is only 105 miles distant.

FROM THE EARLY DAYS

Newcomen Engine Still at Work and Paying Its Way

EVEN progress, since the time of Newcomen, has not sufficed to drive all the machines that he created, out of business. Several are still at work in Great Britain, the oldest being at Farme Colliery, near Rutherglen, Scotland. This is of the atmospheric type, using 10 lb. steam pressure and has the cylinder open at the top. The cylinder was never bored, the piston being packed from time to time with hemp, which with a little water on top keeps the joint sufficiently tight.



OLD NEWCOMEN ATMOSPHERIC ENGINE STILL AT WORK

Alternate admission of steam to raise the piston and of water to condense the steam, is effected by a handle worked by the attendant, and the atmospheric pressure on top of the piston raises the weight.

This engine has been at work drawing coal since 1809 and can lift a cage of about one ton net weight with the 10-lb. steam pressure. As a matter of fact, of course, steam pressure is used only to raise the weight of the piston and attach the parts, the work being done by the atmospheric pressure as the steam condenses.

PREHEATING AIR FOR INTERNAL combustion engines was recently discussed in Le Genie Civil by A. Nougier. The author recommended passing the air over tubes in a preheater taking much the same form as a tubular boiler, the exhaust products from the engine cylinder passing in the reverse direction through the tubes. He claimed that it is possible to construct a heater capable of preheating the air to 175 deg. F., at no load without overheating the air at full load. Such a heater for a 200-hp. motor would be 23 in. in diameter and contain 100 tubes about 40 in. long.—Compressed Air Magazine.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

SYNCHRONIZING ALTERNATORS*

Comparison of Direct Current and Alternating Current Operation; Synchronizing With Lamps Light and Dark; Synchroscopes and Synchronism Indicators

By V. E. Johnson

FIRST comes the problem of knowing when 2 alternating e.m.fs. have their waves coinciding. Evidently a voltmeter would not tell us this, unless connected in some other than the usual way. The simplest method of indicating phase relations is by the use of lamps; these are nearly always used at the present time, though generally in conjunction with other apparatus under the general name of synchronism indicators.

Going back to direct current for the purpose of explanation, let us see how we would parallel d.c. circuits using lamps. In Fig. 9 let B be the direct current buses and C the main machine leads.

Assuming the voltage to be 110, we would connect 110-volt lamps as shown. If the buses and switch points

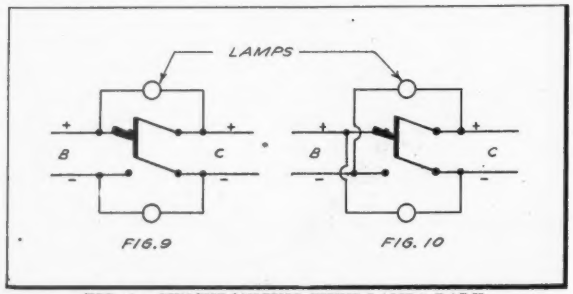


FIG. 9. SYNCHRONIZING WITH LAMPS DARK
FIG. 10. SYNCHRONIZING WITH LAMPS LIGHT

on the generator are of the same polarity and potential the lamps will remain dark, at unequal voltages they will glow with a brilliancy dependent upon the potential difference. If the polarity is opposite, there will be a total of 220 volts across the 2 lamps in series and each lamp will glow at full brilliancy. In other words, when the lamps are dark the switch can be closed as we are synchronizing dark.

To synchronize light the connection would be as shown in Fig. 10. Now, as the lamps are connected between points of opposite polarity it will be seen that the switch should be closed when the lamps are at their greatest brilliancy. This explanation is readily transferred to apply to a.c. single-phase practice.

Wave Variations

REFERRING to Fig. 11, we have 2 alternating e.m.fs. of similar frequency but not exactly in step, with imaginary lamps connected across different parts of the waves. The several diagrams explain this sufficiently.

Thus, without any change whatever, the connections shown in Figs. 9 and 10 could be used for single-phase synchronizing. If the waves coincide perfectly at all points the lamps will remain either light or dark, depending on whether we are using the light or dark method. If the waves do not coincide, say the frequencies differ, then the lamps will flicker, i.e., they will become alternately light and dark, as the potential across the lamps is varied with the shifting wave relations.

*Continued from page 671, July 1 issue.

Lamp Transformers

FIGURE 12 shows the connections applied to 3-phase circuits, both for light and dark synchronizing. If the lamps do not flicker in unison, i.e., if one lamp is bright while the other lamps are dark, the phase relation of the 2 machines is wrong, and we must reverse a pair of leads. For voltages higher than 440, too many lamps would be necessary, so transformers are used in conjunction with them. This does not complicate matters at all, as we can think of the leads as merely coming through the transformers, in no way affecting the preceding explanations. The primary and the secondary e.m.fs. reverse at the same time, so that when the secondaries are in

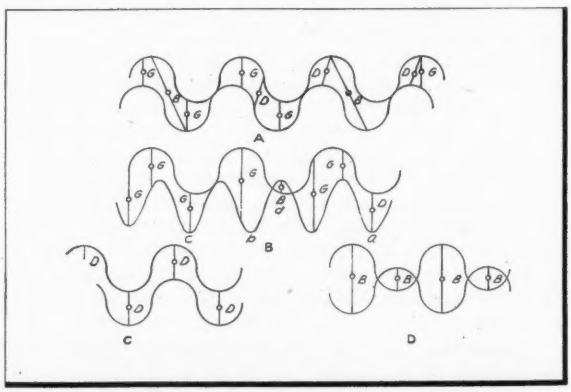


FIG. 11. DIAGRAMS SHOWING EFFECT ON LAMPS WITH VARIOUS WAVE SHAPES AND DISPLACEMENTS

step the primaries must be in step also. Fig. 13 illustrates various connections through transformers in practice, after the machines have once been brought to the proper phase relation, it is quite common to use the lamps in 1 phase only.

Figure 14 shows a diagram using lamps in 1 phase of a 3-phase system, and using sychronizing plugs for convenience in connecting.

Synchronism Indicators

THE great disadvantage of using lamps for synchronism indicators is that they are not definite nor accurate enough. It is impossible to tell which machine is running too fast, and equally impossible to tell exactly when

the machines are in step. With the "dark" method, the lamps will remain dark with several volts potential difference across their terminals, which may mean a great deal if they are in the secondary of a 20 to 1 transformer. With the "light" method, it is impossible to tell exactly when the lamps are at maximum brilliancy, so that by either method the results are more or less inaccurate.

To eliminate these troubles, instruments have been designed which indicate exactly when the 2 machines are in step, and also indicate which one is running faster, i. e., whether the incoming machine is fast or slow. These instruments go under various names, such as synchroscope, synchronizer, synchronism indicators, etc. They are quite simple, and also quite familiar to the engineering profession, but a brief schematic description of their method of operation may not be superfluous.

The apparatus consists essentially of a rotor and field, the rotor carrying the indicating pointer. In one type the armature has 2 windings at right angles to each other, the common point of these 2 windings being connected to one of these slip rings on the shaft, and the other ends to the other 2 slip rings. By means of an external reactance, the current in one of these windings is caused to lag 90 deg. behind that in the other. The field is connected, directly or through transformers, to the terminals of one machine, and the rotor to the terminals of the other machine. Fig. 15 shows the schematic arrangement of connections.

It is evident that when the 2 machines are in phase, the coil A, whose magnetism is in step with the e.m.f. of the machine, will assume a positon as shown at A.

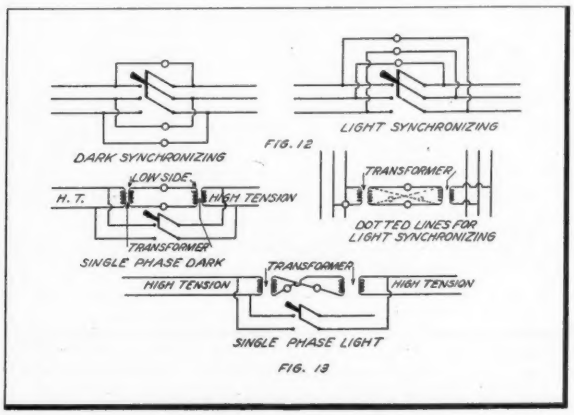


FIG. 12. SYNCHRONIZING A 3-PHASE CIRCUIT WITH LAMPS DARK AND LAMPS LIGHT

FIG. 13. USE OF LAMP TRANSFORMERS ON SINGLE AND 3-PHASE CIRCUITS

If the polarity of either machine be reversed, i.e., if there is a phase change in either one of 180 deg., the coil will be as in B. The pointer will indicate zero or opposition, as the case may be. It is also evident that the coil whose current and magnetism is lagging 90 deg. behind the machine e.m.f. will exert no influence on the position of the rotor, as its m.m.f. is zero when the field m.m.f. is maximum and vice versa.

Now, if the 2 machines are out of step 90 deg., the coil A will not influence the position of the rotor, as its magnetism is now 90 deg. different from that in the field. But, on the other hand, the coil B will now be in step with or in opposition to the field current, and we have the condition shown in Fig. 16, A and B. So for intermediate points the needle assumes a position which indicates in geometrical degrees the phase relation in electrical degrees between the 2 e.m.fs. When they are in step, the pointer indicates O; when 90 deg. out, the pointer, actuated by the reactive coil, indicates 90 deg.; when in opposition, actuated by the non-reactive coil, it indicates 180 deg., etc. As a difference in frequency would cause a continuous changing of the phase angle, the revolutions of the needle would show accurately the relation of the 2 e.m.fs. which we are trying to synchronize, i. e., which has the higher frequency, and also the moment of exact coincidence.

Synchronizing Motor-Generators

IN practice it is customary to adjust the governor of turbines and engines until the pointer on the synchroscope revolves very slowly and then close the switch just as the machine is approaching synchronism. A more complicated case, previously referred to, is that of an a.c. gen-

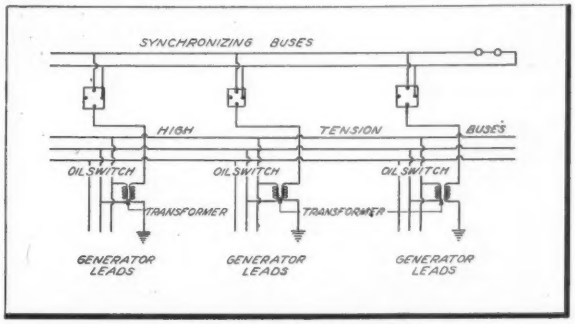


FIG. 14. USE OF SYNCHRONIZING PLUGS

erator driven by a synchronous motor. This is often the case in substations where such motor generator sets are used to change the frequency and voltage.

In this case the speed of the 2 machines cannot be varied after they are locked in step, so that some other means is necessary to establish the proper phase relation. This is done in 2 ways, (a) opening the main switch for an instant and allowing the synchronous motor to drop back 2 poles, or (b), reversing the synchronous motor field repeatedly until the generators are in phase.

Let us take, for example, 2 motor generator sets with 25-cycle motor and 60-cycle generators. Assuming a speed of 300 r.p.m., this will give us 10 motor poles and 24 generator poles.

These machines are so assembled that when a certain motor pole is opposite a certain corresponding motor pole in the other set, a generator pole in one will be opposite a certain given pole in the other. Or, in other words, a motor pole bears to a generator pole in one set the same angular relation as a certain motor pole bears to a certain generator pole in the other.

Now, if the motor and generator had had the same number of poles, a very unusual condition, the generator would be in step, no matter what poles coincided. But for a case such as the one we have assumed, the conditions are as shown in Fig. 17. Here it will be seen (A) that when M is opposite M′, the generator poles will coincide. When M is opposite M'_2 they will not coincide (B) nor when it is opposite M'_3, etc. M and G are one set. M′ and G′ are the other set.

Suppose Fig. 17 (C) illustrates the condition after the motors are paralleled. Evidently the generator waves do not coincide. Reversing the motor field gives us (D), still not ready for paralleling. So on, repeated reversals gives us (E) and (F), this last one being in step and ready to be thrown together. One more reversal and we have a condition similar to that in (C), i. e., it takes 5 reversals of the motor field to go through one cycle of

events, from synchronism back to synchronism or from any other phase relation back to that same phase relation.

Looking at the matter mathematically, we can say: If 10 motor poles occupy 360 deg. and 24 generator poles occupy 360 deg., then 1 motor pole occupies as many degress as 2 2/5 generator poles. Then say the 2 machines are in step, and the motor field is reversed, we will have the motor dropping back one pole and the generator 2 2/5 poles. This would give us 2/5 of a pole opposite same pole on the other set. A second reversal would bring us 2 motor poles or 4 4/5 generator poles from the original position, 3 reversals would give us 3 motor and 7 1/5 generator poles (still 1/5 of a pole face opposite a pole in the other machine), 4 reversals would give us 4 motor poles and 9 3/5 generator poles, still out of step, 5 reversals would give us 5 motor poles and 12 generator poles. The poles now coincide again.

It frequently happens that when the machines are parallel for the first time the pole faces may coincide, but the polarity of the generators is wrong. No amount

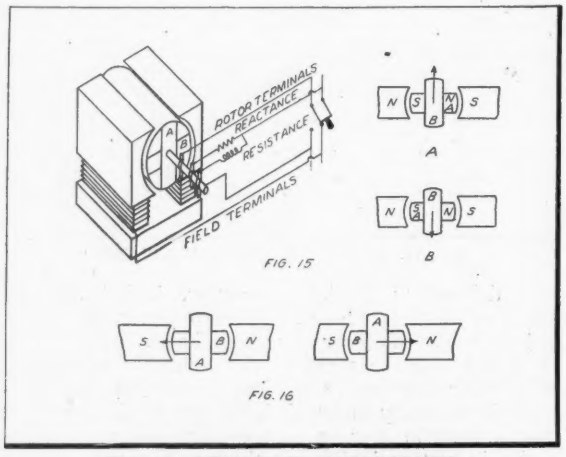


FIG. 15. DETAILS OF SYNCHROSCOPE
FIG. 16. ACTION OF SYNCHROSCOPE

of motor field reversing could remedy this, so the generator field must be reversed.

Following up the above reasoning, an 8-pole motor and 36-pole generator set would need to have its motor field reversed twice, a 12-pole motor and 32-pole generator 3 times, etc. Divide the number of poles on the motor by the greatest common divisor of the numbers representing the poles of the motor and generator, and the result will be the number of reversals necessary for one cycle of events.

The method of bringing about proper phase relation by opening the main switch is only possible when a synchroscope or some other synchronizing device is attached to the motor lines. The motor and line sides of the main switch are plugged to the indicator, and the main switch opened. Immediately the motor begins to drop back, and the pointer on the synchronism indicator rotates. When the pointer has revolved once and returned back to 0 the switch is closed. If the switch is left open longer, the difference in frequency will become so great that it is almost impossible to get the switch in at the instant of coincidence.

One reversal of the motor field dropped the motor back one pole. One opening of the main switch would of course drop back 2 poles. So that for one complete cycle of events we would only need to open the switch ½ as many times as we would need to reverse the field, if, of course, the number of poles to be dropped is divisible by 2.

One disadvantage of this method is that it necessitates 2 synchroscopes. This has been overcome by using one synchroscope with 2 pointers, one for the motor and one for the generator. Upon opening the main switch, the motor pointer would make one revolution, while the generator pointer would make several, depending on the relation between the poles in the motor and the poles in the generator.

Automatic Synchronizers

ALTHOUGH the synchroscope is a most desirable device, it does not perform the actual work of closing the a.c. switch, but merely indicates when the conditions for closing the switch has been reached. In order to eliminate the danger which exists when switches are operated manually, use is made of an automatic synchronizer which closes the switch when the speed of the incoming machine is correct and its e.m.f. in time phase with the supply system.

An automatic synchronizer may be constructed of 2 solenoids acting oppositely upon a relay switch lever, the rapid movement of which is retarded by a dashpot. One of the solenoids should be connected to tend to close the switch when the e.m.f. of the incoming machine is directly out of phase and the other should tend to open the switch when the e.m.f. is directly in phase with that of the supply system.

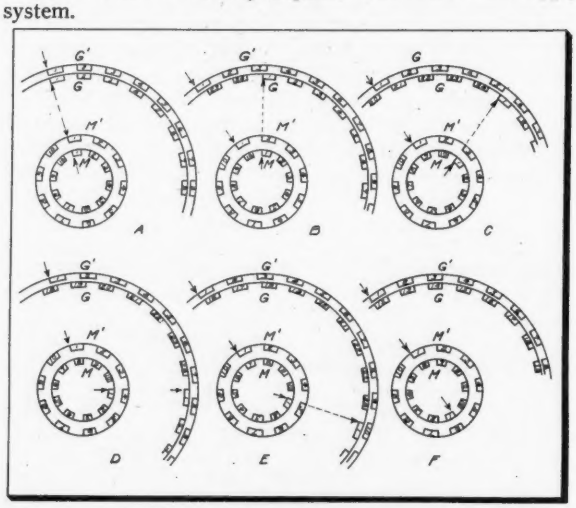


FIG. 17. RELATIVE POSITION OF POLE PIECES IN MOTOR-GENERATOR SETS

When the speed is either too fast or too slow the solenoids tend alternately to open and close the switch, the dashpot preventing the switch from being closed completely. When the speed is correct and the e.m.f. of the incoming machine remains in time phase with the supply e.m.f. for a sufficient length of time, the dashpot allows the proper solenoid to close the switch when the phase relation is correct.

WE SOMETIMES FORGET what the word engineer means. In its derivation, it has no reference to engines. The engineer means the man who is ingenious, inventive, of wide-awake and active mind, who can meet and master situations with science and skill. If we remember that derivation, we will all agree that the word describes the highest and best type of engineer, the type we ourselves aim to be. Our work does not begin with the throttle and end with the flywheel; it does not even begin with the coal pile and end with a salary check; it is a part of the great work of efficient men all over the world —making two blades of grass grow where one grew before.—Ice.

THREE-WIRE GENERATORS

How the Addition of Collector Rings and Balancing Coils on Ordinary Direct-Current Generator Forms a Self-Contained 3-Wire System

THREE-WIRE systems for the distribution of electrical energy at low voltages, direct current, were developed during the pioneer period of the art of electric lighting. They have been and are now used extensively for energy distribution for light and power over short distances, principally because of the copper economies that they effect. Current is transmitted at twice the voltage of the lamps or other apparatus connected between the neutral and one of the outside wires.

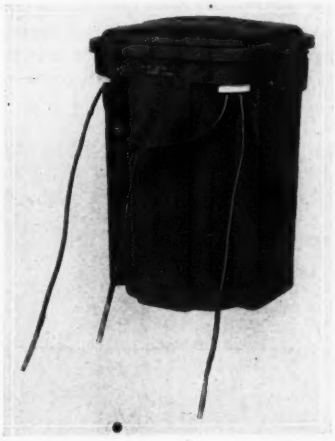


FIG. 1. THREE-WIRE GENERATOR BALANCE COIL IN CASE

The neutral wire carries only the unbalanced current, the value of which is determined by the difference in the loads on the two "side circuits" of the system. The transmission of current at twice the receiver voltage results in saving of copper cost, with a given energy loss in the line, of nearly two-thirds as compared with the copper cost of a 2-wire system of a voltage equal to the lower of the 2 3-wire system voltages. Half voltage obtained from either side of the system is often convenient for variable speed motor operation. Power consuming devices, motors especially, can also be connected across the higher of the two voltages.

Construction of 3-Wire Generators

WITH the addition of certain parts, any regular single-voltage, direct-current generator can be adapted to provide 3-wire voltages. The principal difference between 3-wire generators and standard, single-voltage, direct-current machines is that, with the 3-wire generator, auto transformers or balance coils, shown in Fig. 1, are added and certain connections to the balance coil windings are provided, as shown in the connection diagram, Fig. 2.

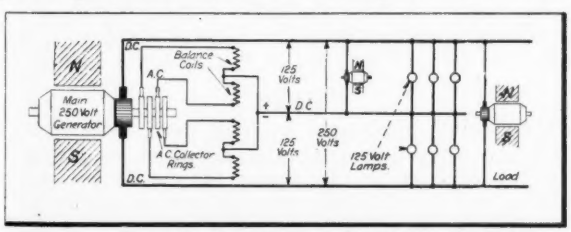


FIG. 2. CONNECTION DIAGRAM OF 3-WIRE GENERATOR

Collector rings are mounted at one end of the armature, as shown in Fig. 3, and the connecting leads to them are similar to those employed on the alternating-current side of a rotary converter.

Balance Coil

FIGURE 1 shows the balance coil (sometimes called auto-transformer), which is connected across each pair of 2-phase collecting rings. This balance coil consists of a single winding on a laminated iron core, and is similar in mechanical construction to a distributing transformer. The assembled coils are contained in a cast iron case similar to those employed for transformers. The middle points of the balancing coils are interconnected, and from this connection the neutral lead of the 3-wire system is brought out as shown in Fig. 2.

Characteristics

THREE-WIRE generators may be compounded to impress an increasing voltage with an increasing load, as is the usual practice with single voltage machines. It is customary to divide the series field turns into 2 parts, connecting one part in the positive and the other in the negative line in order that the regulation may be preserved at all loads. Commutating poles assure sparkless commutation from no load to heavy overloads.

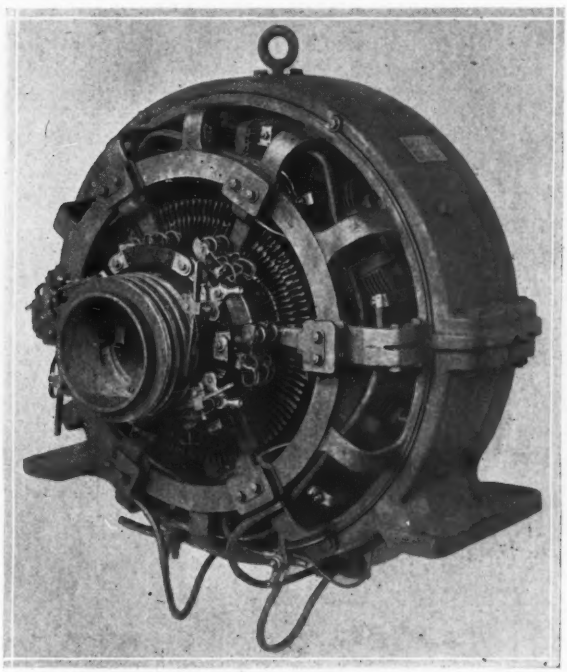


FIG. 3. THREE-WIRE GENERATOR SHOWING COLLECTOR RINGS. MANUFACTURED BY WESTINGHOUSE ELECTRIC & MFG. CO.

Three-wire generators may be operated in parallel as satisfactorily as 2-wire machines. The balance coils are connected directly to the collector rings, and the neutral wire is carried to the switchboard. It is therefore unnecessary to synchronize or connect the alternating-current sides of the armatures in parallel; nor is it necessary to consider the frequency of the alternating-currents generated in the armatures of the different machines. Three-wire generators can be operated in parallel irrespective of the number of poles and speed of each just as easily and simply as 2-wire generators can be regulated for equal voltage; 2-wire and 3-wire generators can be operated in parallel with each other and the latter will handle any unbalanced load.

In large stations with many units, it is, therefore, only necessary to operate 1 3-wire generator, provided it has sufficient capacity to carry the difference between the loads on the sides of the system. All of the other machines may be of the single-voltage type. It is, however, advisable to install duplicate 3-wire units each of sufficient capacity to provide for the maximum unbalanced condition of the system.

EDISON STORAGE BATTERIES

Some Pertinent Suggestions for Their Care and Operation

EDISON storage batteries at the present time are largely used for electric vehicle and street railway work and frequently come under the charge of a plant engineer. As their construction and operation vary considerably from the lead-plate batteries, to successfully operate them, the engineer must acquire some knowledge of their charactristics.

Positive and Negative Plates

POSITIVE plates are composed of 30 nickeled steel perforated tubes mounted in 2 rows upon a steel grid. These tubes, which are twisted from a ribbon

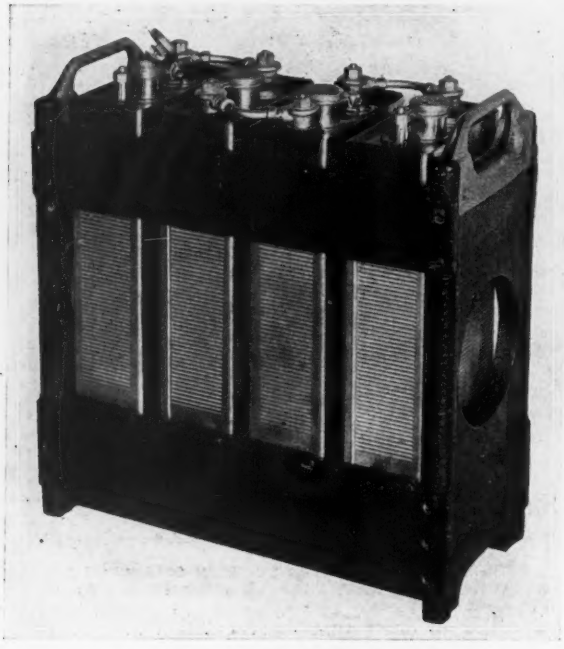


FIG. 2. FOUR TYPE A-4 CELLS IN TRAY

of perforated sheet steel, are filled with alternate layers of nickel hydrate and pure metallic nickel in exceedingly thin flakes. The positive active material, nickel oxide, is put into the tubes in the form of nickel hydrate which is changed into the oxide on the first passage of current through the cells. The metallic nickel is placed in the tube to give perfect conductivity between the center and the outside, so that the active material is uniformly useful throughout the tubes. Each tube, 4 in. in length, contains 300 layers of each material.

Negative plates consist of 24 rectangular pockets of nickel plated steel containing the negative active material, iron oxide. These pockets are pressed into the steel supporting grid by a powerful press which corrugates their surfaces and forces them into integral contact with the grid.

Theory of the Edison Cell

STARTING with iron oxide in the negative, green nickel hydrate in the positive, and potassium hydrate in solution, the first charging of a cell reduces the iron oxide to metallic iron while converting the nickel hydrate to a very high oxide black in color. On discharge the metallic iron goes back to iron oxide and the high nickel oxide goes to a lower oxide, but not to its original form of green hydrate. On every cycle thereafter, the negative charges to metallic iron and discharges to iron oxide, while the positive charges to a high nickel oxide.

Current passing in direction of either charge or discharge decomposes the potassium hydrate of the electrolyte and the oxidation and reduction at the elec-

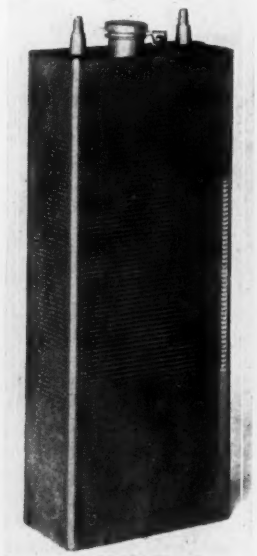


FIG. 1. EDISON TYPE A-4 CELL COMPLETE

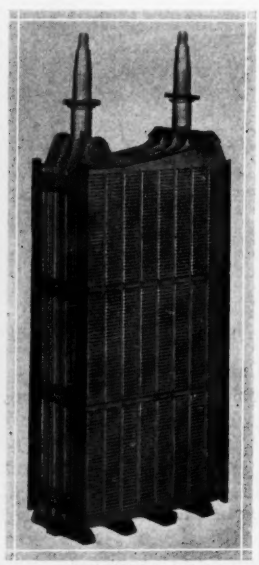


FIG. 3. ASSEMBLY OF PLATES SHOWING INSULATION

trodes are brought about by the action of its elements. An amount of potassium hydrate equal to that decomposed is always re-formed at one of the electrodes by a secondary chemical reaction, and the consequence is there is none of it lost and its density remains practically constant. The eventual result of charging, therefore, is a transference of oxygen from the iron to the nickel electrode, and that of discharging is a transference back again. This is why the Edison is sometimes called the "oxygen lift" cell.

Charging

INSIDE of the maximum working limit, perhaps 30 per cent more than the rated output, it is optional with the user as to the length of charge he shall employ, and this should be regulated according to the output required in any particular service.

It should be borne in mind, however, that in utilizing the highest available capacity of a battery, efficiency is sacrificed; that is, charging current is wasted. The wasted current goes to decompose water which escapes as gas, and consequently distilled water must be added to the cells more frequently than under normal conditions. Long charges also are likely to

cause excessive heating, and care should be taken to keep this within the prescribed limits.

On the other hand, if very high output is not required, and a battery will do its work when charged say 4 to 7 hr. at normal rate, the current efficiency will be very high, and filling will not have to be attended to so frequently, while the amount of heating will be small.

A 7-hr. charge at normal rate is arbitrarily chosen as the normal charge, the reason being that under these conditions the highest output obtainable with little sacrifice of efficiency is realized.

Incidental Considerations

LACK of capacity in a battery may be due to grounds between cans or through the supporting structure; to low temperature, as on a cold winter day; to excessive temperature during charge; to depletion of potash in the electrolyte; or to carbonation of the potash.

Grounds are best avoided by following closely the directions as to "Cleaning" and by taking care that the retaining cans do not get together by any chance and that nothing of a metallic nature gets between them.

Depletion of the electrolyte is brought about principally by improper filling of cells, for, when the solution is too high above the plates, it is liable to be forced out in bubbles by the escaping gas.

Carbonation comes from the use of water which has been exposed to the air and has absorbed carbon dioxide from it, or which has become carbonated in some other way.

Depletion of electrolyte can be detected by specific gravity readings, but the amount of carbonation can only be determined by a chemical analysis. Both of these troubles are remedied by a complete renewal of of electrolyte, which should be done, anyway, every eight to ten months, as explained under "Electrolyte."

If it should be found, in taking a specific gravity reading, that the electrolyte in any cell is much weaker than the average, this cell should be examined for a possible leak. If a cell is found to be leaky it can be put in a new retaining can at the factory.

Temperature

THE best results are obtained from a battery when the temperature is kept between 70 and 90 deg. F. For this reason it is advisable to have the garage reasonably warm in winter and well ventilated in summer.

Battery compartments should always be kept open while battery is charging. All holes or openings in the battery compartment should be sealed or closed tightly during the cold winter months, so that the cells will retain their heat while out on the road.

The temperature of a battery should never be allowed to go above 100 deg. F. during charge, or 115 deg. during discharge.

Filling

IN filling use only pure distilled water. Do not use aerated or carbonated water. Most drinking water is carbonated, and also contains injurious salts.

Water to be used for filling should not be left exposed to the air. It should be kept corked up in glass bottles or in carboys. Proper height of the solution is ½-inch above the plates. Never allow the solution to get below the tops of the plates.

As a matter of precaution it is recommended that a battery in regular service be looked over twice a week. Filling should be attended to before batteries are put on charge, for in charging the solution is raised to a false level. Filling apertures should be kept closed except at such times as they are being used for filling purposes.

Cleaning

IF dirt is allowed to accumulate between the cells it is liable to become moist with water and potash and an electrolytic action will result, which in time may corrode the retaining cans. If the retaining cans become corroded or rusted they should be coated on the sides and bottoms with vaseline. It is not advisable to vaseline the tops of cells.

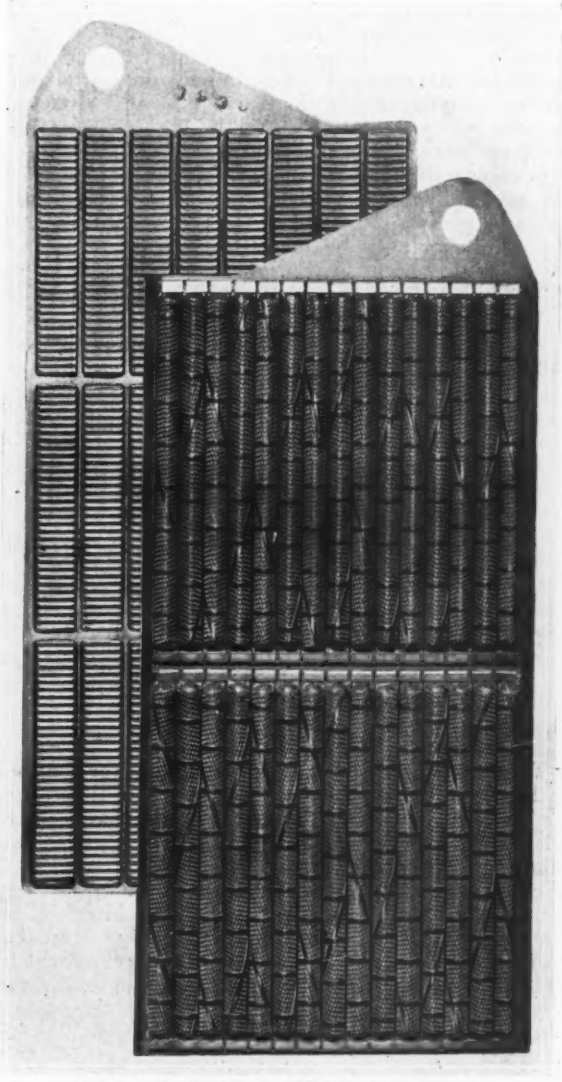


FIG. 4. POSITIVE AND NEGATIVE PLATES

For a thorough cleaning, cells should be taken out of the trays, washed off and dried. The trays should be cleaned and dried thoroughly before reassembling the cells. The block insulators or rubber aprons on which the cells rest should always be cleaned and coated with vaseline before reassembling. Vaseline will not adhere to the retaining can if the can is moist.

Electrolyte

ELECTROLYTE in an Edison storage battery is a 21 per cent solution of Potash (KOH), containing a small amount of Lithium. Both of these ingredients

are alkaline. Never under any condition put acid in the cells. The normal specific gravity of a 21 per cent solution of the Potash is 1.200. The efficiency and capacity of a cell is not affected to any great extent until the specific gravity falls below 1.160. If the specific gravity is allowed to fall below 1.160 a temporary effect will be noticed in the output. The specific gravity does not change during charge or discharge.

If specific gravity readings are taken they should be made at the end of a charge, by which time the distilled water used in filling will have had ample time to mix thoroughly.

The solution in an Edison storage battery in daily operation should be changed every eight or ten months, the old solution emptied out and new solution put in. After pouring out the old solution fill immediately with the new, being careful not to allow the cell to stand empty for more than a few minutes.

In cases where the specific gravity falls below 1.160 it is advisable to renew the whole electrolyte rather than add potash solution, as by adding potash the solution is liable to be made too strong, with the possibility that permanent injury will result.

It requires about 2.64 lb. of potash solution to refill an A-4 cell, 3.96 lb. to refill an A-6 cell.

The following table shows the voltage necessary to charge various numbers of cells:

20	cells	require	line	voltage	of 37.	Volts
24	"	"	"	"	44.4	"
28	"	"	"	"	51.8	"
32	"	"	"	"	59.2	"
36	"	"	"	"	66.6	"
40	"	"	"	"	74.	"
44	"	"	"	"	81.4	"
48	"	"	"	"	88.8	"
52	"	"	"	"	96.2	"
56	"	"	"	"	103.6	"
60	"	"	"	"	111.	"
64	"	"	"	"	118.4	"
68	"	"	"	"	125.8	"
72	"	"	"	"	133.2	"
76	"	"	"	"	140.6	"
80	"	"	"	"	148.	"

To maintain the normal rate throughout the charge, the line voltage must average at least 1.85 times the number of cells in series. For example, to charge sixty cells in series it would be necessary to have a line voltage of 60 times 1.85 volts, or 111 volts.

If the line voltage be 1 per cent or 2 per cent lower than that specified in the table it will not interfere to any great extent with the charge, the only difference it will make being at the end of the charge, at which time it will be impossible to maintain the normal rate. A battery of 60 cells can be charged in a very satisfactory manner on the universal direct current line of 110 volts.

THE SURVEY'S ESTIMATE on January 2, 1912, indicates a copper output for 1911 greater than that of 1910 and nearly equal to the record production of 1909. It is further stated that most of the companies are now in a position to maintain or even increase their present output, so that, if the consumption of the metal will permit, the production of copper in the United States for 1912 may be expected to show a marked increase. It is noteworthy that not one of the leading copper districts of the United States, several of which have been active producers for 30 yr. or more, has been worked out or shown a decrease in its ability to produce copper.—Valve World.

PRACTICAL ELECTRICAL ENGINEERING

Electrical Horsepower, the Watt, Kilowatt and Kilowatt Hour, Heat Losses

IF an electric motor is operating on a 110-volt circuit and is drawing 20 amperes from the line, neglecting efficiency, what horsepower is it taking? Here we must introduce the unit of power, the watt, which is the rate of doing work, when 1 ampere flows at 1 volt electromotive force. Voltage is variously termed, potential or difference of pressure or of electromotive force, the latter term being most common. A horsepower is equivalent to 746 watts. Returning to the problem we have $(110 \times 20) \div 746 = 2.9 +$ hp.

Fifty 16-c.p. incandescent lamps, consuming 55 watts each are connected in multiple to a 110-volt circuit. What horsepower is used up in these lamps?

Here it is evident that the voltage does not enter into the calculations as the rating of the lamps is given in watts so that the solution is $(50 \times 55) \div 746 = 3.6 +$ hp.

Consider the same problem, but instead of rating the lamps in watts assume that they are rated at ½ ampere each, then the solution would read $(50 \times 0.5 \times 110) \div 746 = 3.6 +$ hp.

It has been shown that electric power is the rate at which energy is being transformed in a circuit and is the product of the electromotive force (e.m.f.) and current. The practical unit is the kilowatt (kw.) and is 1000 times greater than the watt.

If a motor operating on a 110-volt circuit is drawing 25 amperes from the line, how many kw. is it using? $(110 \times 25) \div 1000 = 2.75$ kw.

If this motor operates 10 hr. a day, 26 days in the month, how many kilowatt-hours will be used? The amount of electric energy transformed in a circuit is measured by the product of the power and the time and is denoted by the kilowatt hour (kw.-hr.). The total number of hours the motor operated is $26 \times 10 = 260$, then $260 \times 2.75 = 715$ kw.-hr. Current is now almost universally metered, the meter registering the consumption in kilowatt hours.

In every electric circuit where current is flowing heat is developed, owing to the resistance to the passage of the current. This heat is termed heat loss and is expressed in watts. If a resistance is designed to reduce 110 volts, the e.m.f. of the line, to 80 volts on the apparatus with a current of 5 amperes, what is the heat loss?

It has been determined experimentally that the heat loss in watts is equivalent to the current squared multiplied by the resistance or expressed as a formula: $W = I^2 \times R$. To secure the desired drop of 30 volts, by Ohms law we have $R = 30 \div 5 = 6$ ohms. Then the watts lost by heat are $5^2 \times 6 = 150$.

In a 110-volt line supplying 20 amperes current to a motor there is a 5-volt drop. What is the heat loss? $R = 5 \div 20 = 0.25$ ohms. Then $5^2 \times 0.25 = 6.25$ watts. Ans.

ACCORDING TO DAVID ROSS, secretary of the bureau of labor statistics, up to the present time about 500 manufacturers have accepted the compensation law and 2300 rejections have been filed. Only a few employes have been heard from, but these are all rejections, as would naturally be the case, as the acceptance is understood if the rejection is not filed.

COST OF POWER

Necessity of Operating Engineers Knowing What It Costs to Generate Power

AT one of the isolated plants of Boston, a few days ago the chief engineer remarked that it is entirely the fault of the chief operating engineer of each isolated plant for the invasion by central station power of the isolated plant field, and upon him rests the whole blame. It is claimed that very few of the isolated plant engineers have taken sufficient interest in their work, in the welfare of their future to bring themselves up to the realization that it is necessary for each and every one to study methods for determining cost of power, itemized and as produced in the plant of his charge.

In the discussion of the many factors which enter the subject of "Isolated plant versus Central station power," there are many, very many, flexible points which to the student of either side of the question may be bent or twisted to serve as an argument in favor of that side of the question in which an individual may be more interested.

Tersely, arriving at once to the point, the central station interests have, following a desire to increase the sales of their product even though on a small margin, prepared themselves to place before the owners of isolated plants such arguments as would induce the prospective purchaser to do away with part of his equipment, whether in factory or building, and to purchase from the central station the power that equipment formerly produced. And, the isolated plant engineer, while the central stations have been making their preparations, has been standing pat awaiting to see what would happen.

His protest was useless; he was unable to refute the arguments put forth by the central station people; he knew that there must be a nigger in the wood pile, but he could not disclose it—he did not know his cost of power. In other words, that matter, which the central station interests have considered worthy and of sufficient importance to make a business of, has only slightly, and from a superficial viewpoint, interested the average of those men whose future welfare actually rests upon it.

The average isolated plant engineer is the man here spoken of, and that means that the indifferent, not interested kind, are in the majority; but not so with the minority; those engineers who are up-to-date and realize the importance of their position, the few engineers from that great practical school who have instigated the idea that operating engineering is a profession. By the influence of this minority that agitation today on the question of "isolated plant versus central station power" is developing strides of advancement in favor of the life of the isolated plant. Records of itemized cost of power are becoming more obtainable, and with these it is hoped to be able to meet on a fair and open ground any and all arguments which can be presented by central station interests; further, the discussion will enable it to be proven that in some cases operating engineering is truly a practical profession, and hence consistently, the value and prestige of the practical, professional engineer will be rightly enhanced.

It is believed by many that these central station power invaders of the isolated field have, practically speaking, reached their limit; the future will disclose but few isolated plant possibilities which are willing to bow down in allegiance to the whims and desires of central station authorities.

It is doubtless true that a large amount of power can be produced at the switchboard of a central station or a large plant at a less cost than it is possible to produce power in the small isolated plant which constitutes the average. But there are other expenditures to be figured in besides the mere production of the power; every kilowatt sold must not only pay for its production, but there must be included the transmission and the maintenance of the transmission lines. Further, in many cases must be added the maintenance of one or several franchises, and to this account may be charged many items of which lobbying and legal fees may in some cases represent large amounts.

Notwithstanding all the deduction and controversy which the subject has occasioned the final conclusions must be made from consideration of the individual case or plant. If the central station power can be used at a less cost than can be produced by any individual isolated plant the reason for such a condition may, nine cases out of ten, be found in the lack of efficiency in the production of power by the isolated plant. As has been many times explained the product of sale of a central station is direct power in power units or kw. hours, while the product of sale of so-called industrial establishments or isolated plants is not a unit of power. In this latter case the power is simply used, and its cost is only an item in the cost of manufacture of the product of sale, which may be the yard of cloth, or the pair of shoes, etc. Therefore, very logically the central station feels a more direct incentive for efficiency in the production of power. If the same amount of efficiency were to be found in all isolated plants as is found in the average central station plant, there would be no invasion of one by the other.

The central station interests' most frequent victims have been the isolated plants of office buildings, where steam is used for no other purpose, excepting the generation of power, than for the heating of the building, and where it is possible for the building owners to purchase central station electricity for lighting in quantity at a minimum rate through a master meter and to dispense the light to the building tenants through individual meters at a short rate. No other type of isolated plant of the average is more vulnerable to central station arguments, and it would seem that if in a single case the isolated plant of an office building can be discovered which operates with an efficiency such as would place entirely out of question the offers of the central station, there should be little need of fear of the results of a comparison under possible conditions in any other kind of isolated plants.—The New England Engineer and Master Mechanic.

AT THE CLOSE of 1911 there were 465 miles of railways in the Territory of Alaska, compared with 371 miles in 1910. This mileage is distributed between 9 different railways from 5 to 196 miles in length. The existing railways emphasize the need of additional transportation facilities. The most urgent need is for a railway to connect an open port on the Pacific with the Yukon basin. Until such a line is built only the richest placers of the interior and only the most favorably located lodes can be profitably exploited.—Cassier's Magazine.

VENTILATION OF PENNSYLVANIA TUNNELS AT NEW YORK CITY

Requirements for Pure Air, Forced Draft System Employed, Results of Tests on Fans

By B. W. Bennett

At the time of the building of the new Pennsylvania Railroad terminal at New York City, the ventilation of the 15½ miles of tunnels leading from the station at Seventh Avenue and Thirty-third Street under the Hudson River to Hackensack, N. J., and under the East River to Long Island City, and running the full width of Manhattan Island, under the city, was considered a matter of prime importance.

In the design of such a ventilating system, 2 main factors had to be considered. First, it was necessary that sufficient ventilation be supplied to make the tunnels safe under all emergency conditions, and, second, it was highly desirable that such a standard of purity be maintained, that passengers should suffer no discomfiture during times of normal operation, due allowance being made for occasional irregular spacing of trains. In order to obtain these results, it was decided to maintain a standard of purity in the cars of not more than 8 parts of carbon dioxide in 10,000 parts of air. This was equivalent to supplying 30 cu. ft. of air per minute to each passenger, and in the case of the tunnels under the East River was equal to approximately a 20 min. air change. To insure that the full amount of air desired be supplied to the occupants of the cars, it was decided to deliver to the tunnels 50 cu. ft. of air per minute per person, or ⅔ more than was actually required to maintain the desired standard of purity.

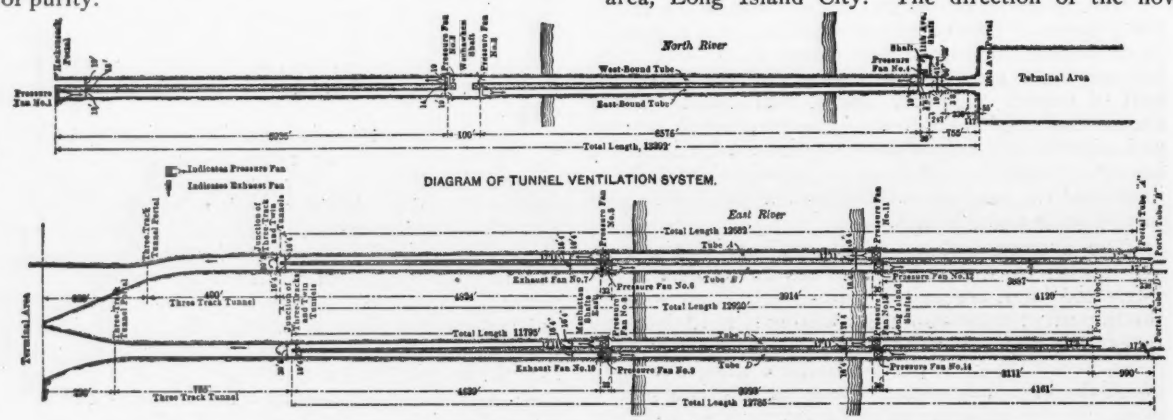


FIG. I. DIAGRAM OF THE VENTILATION SYSTEM IN THE PENNSYLVANIA TUNNELS

The first and most important feature to be considered, with respect to the ventilating system, was the general layout or scheme and various systems for obtaining the requisite ventilation by exhaust, by pressure and by a combination of both were considered. After due consideration, the system found to be best adapted to local conditions was a forced draft system of the same kind as used for ventilating a number of railroad tunnels going through the mountains. In this system, the air is introduced in a stream of constant flow, through a divided nozzle which delivers it on each side of the tunnel through expanding outlets, placed in the bench walls. In every case these outlets direct the flow of the air stream in the direction of traffic in the various tubes or tunnels. After the installation, it was found by test that a decided injector effect was obtained by the use of these special outlets. This effect was so pronounced in the case of the North tunnel under the Hudson River, that a strong current of air was induced, which flowed from the East entrance of the tunnel toward the fan, which is placed about 750 ft. from this entrance and blows toward the West end of the tunnel.

Further advantage obtained by the use of the system described above is the absence of obstructing duct work in the tunnels, thus leaving the side benches entirely free for walkways. The ducts leading from the fans to the various nozzles were designed in each case to suit local conditions, particular attention being paid to the elimination of sharp bends, which would result in losses due to friction. Care was also taken that there should be no abrupt changes in cross section in these ducts, as such changes would result in sudden changes in the velocity of the air and a consequent loss due to the conversion and eddy currents. The accompanying photograph of these ducts, taken during erection, illustrates the great care given to this part of the installation.

A diagram of the tunnel layout and of the ventilating system is shown in Fig. 1. The upper diagram shows the layout of the systems extending from Hackensack to the terminal area, and the lower diagram the layout of the system extending from the terminal area, Long Island City. The direction of the flow of the air from the various fans is indicated by arrows. In each case this is in the direction of traffic in the individual tunnels. The tunnels are so constructed that each tube is entirely separated from the others, thus preventing the by-passing of air between the tubes, which condition has proven so detrimental in the case of the subways in London and in other notable cases.

After the volumes of air required for the various sections of tunnel had been determined by the engineers of the Pennsylvania Tunnel & Terminal Company, the plans of the tunnels, shafts and fan houses were sent to the fan manufacturers with a request for recommendations and proposels for the fans to deliver the required volumes through the various systems, as

indicated on the plans. There are 14 fans in all, 12 of which are used as supply fans. The other 2 fans which are located at First Avenue are exhausters and draw the air from the terminal area through the South tunnels under Thirty-third and Thirty-fourth Streets. These fans were so arranged in order to prevent the vitiated air from the North tunnels under these streets from being blown up into the station proper. The 2 accompanying photographs show a typical double inlet supply fan and one of the exhaust fans.

FIG. 2. AN EXHAUST FAN USED IN PENNSYLVANIA TUNNEL

The fans used are Sirocco fans, and are particularly adapted to this work, due to the relatively small space occupied by a fan for a given volume and due to their high efficiency. These fans have wheels of the multiblade, drum type. Some of the fans are double inlet fans while others are of the single inlet type. The type used at each location is given in the table of test results below. The fans are all belted to induction motors and are equipped with 3 step cone pulleys, by which speeds of 70 and 40 per cent of the minimum can be obtained.

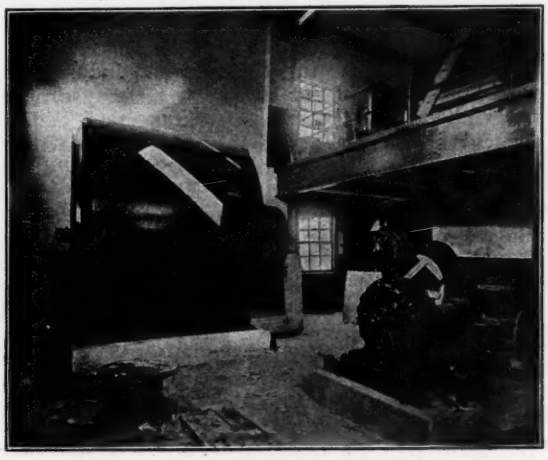


FIG. 3. DOUBLE INLET SIROCCO FAN AT FIRST AVE. AND THIRTY THIRD ST.

After the installation was completed, tests of all the fans were made by the engineers of the Pennsylvania Tunnel & Terminal Company and of the American Blower Company. A tabulation of the results obtained is given below, together with a list of the location of the various fans:

TEST RESULTS—PENNSYLVANIA TUNNEL FANS

Location	Fan No.	Blower or Exhauster	Direction of Air	Diam. Wheel in In.	Approximate length of tunnel ventilated, in ft.	Fan capacity at normal speed, in cu. ft. per min.	Velocity at fan outlet, in ft. p. m.	Brake HP. at Motor.
North River—Hackensack Portal. Building over Portal	1	B	E	60	5900	87000	3920	48.6
North River, Weehawken Shaft, in room between tracks below bench level	2	B	E	60	6600	125800	5670	97.0
	3	B	W	54	6000	100800	5580	56.8
North River—Eleventh Av. Shaft, in room at track level on north side of west bound tube	4	B	W	60	6600	107000	4830	68.5
East River—First Ave. Shafts, in building located at ground level over tracks 3 and 4	5	B	W	72	4800	100000	3130	62.0
	6	B	E	54	3900	60000	3330	21.0
	7	E	E	66	4800	59200	4400	27.9
East River—First Av. Shafts, in building located at ground level over tracks 1 and 2	8	B	W	72	4800	100000	3130	62.0
	9	B	E	54	3900	60000	3330	21.0
	10	E	E	66	4800	59200	4400	27.9
East River—Long Island City Shafts, in building located at ground level over tracks 3 and 4	11	B	W	54	3900	65000	3600	24.3
	12	B	E	54	4100	65000	3600	24.3
East River—Long Island City Shafts, in building located at ground level over tracks 1 and 2	13	B	W	54	3900	65000	3600	24.3
	14	B	E	54	4200	65000	3600	24.3

Anemometer tests in the tunnels showed that the average air velocity due to the operation of the fans alone was about 8 miles an hour, but this is increased to as high as 30 miles an hour, due to the piston action of the trains.

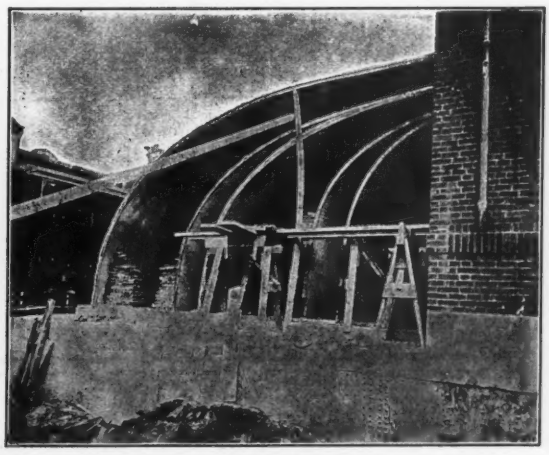


FIG. 4. DISCHARGE DUCTS OF DOUBLE INLET PRESSURE FAN UNDER CONSTRUCTION

A CEMENT THAT will resist white heat may be made of pulverized fire clay, 4 parts; plumbago, 1 part; iron filings or borings free from oxide, 2 parts; peroxide of manganese, 1 part; borax, ½ part, and sea salt, ½ part. Mix these to a thick paste and use immediately. Heat up gradually when first using.—Exchange.

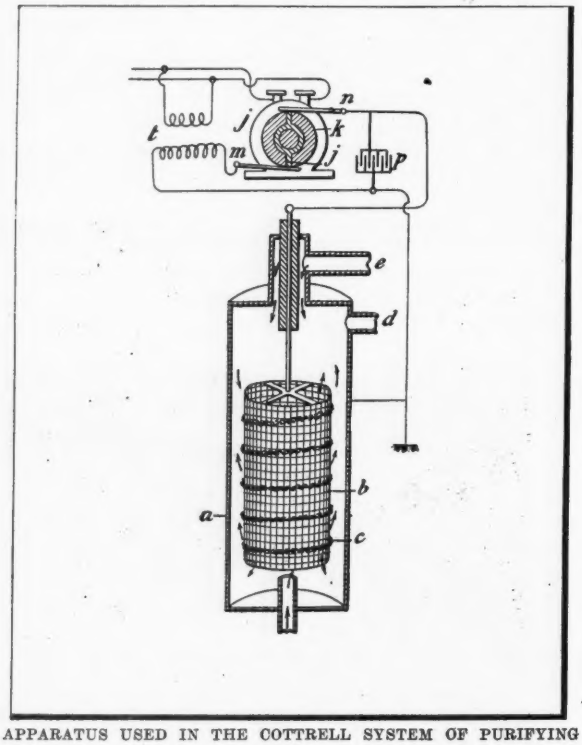
EUROPEAN POWER PLANT PRACTICE

By Francis G. Wickware

THE PURIFICATION OF GAS BY ELECTRICITY

FOR many years electrical means have been employed for the precipitation of particles of solid matter from the waste gases of metallurgical furnaces. As long ago as 1885 electricity was applied to this purpose in English lead works, but the development of practical processes of wide application is comparatively recent. Most of the systems are based on magnetic attraction; the Elsner system, one of the best known, removes solid matter from copper-smelter fumes by placing in the furnace mouth powerful electromagnets, upon which dust accumulates to be removed later by brushes.

For the purification of industrial gases, however, magnetic attraction is of very limited value, on account



APPARATUS USED IN THE COTTRELL SYSTEM OF PURIFYING GAS

of the low permeability of the solid matters ordinarily carried by producer gas or the waste gases from boiler furnaces. For this reason the Cottrell system, recently described in the Revue Industrielle, is of more than ordinary interest.

Investigations of the discharge of electricity through gases have shown that when a gas carrying solid particles passes between 2 high-tension electrodes, a movement of translation from one electrode to the other is set up among the particles.

It is on this property that the Cottrell system is based. One of the electrodes is of some fibrous, nonmetallic material, such as cotton or flax, while the other is of smooth metal. The electrodes, both of the same polarity to prevent arcing, are connected with an alternating current. The apparatus is shown in the accompanying figure.

Gas to be purified enters the lower end of a metallic cylinder a, which forms one electrode, and passes around the other electrode b, on which is wound a coil of fibrous material c. The purified gas leaves the cylinder at d. A current of gas entering at e prevents the accumulation of dust on the wall of the cylinder and carries it to the bottom.

The current is sent to the electrodes by a rotating interrupter k, closing the circuit twice per revolution by means of the contact j and the brushes m and n. A transformer t and a condenser p complete the apparatus.

SPONTANEOUS COMBUSTION OF LIGNITE BRIQUETTES

IT is well known that soft coals in storage undergo a certain loss of heating value, due to the low-temperature distillation of the volatile constituents. Through the chemical action between these liberated hydrocarbons and the oxygen of the air or the moisture in the coal, heat is generated, in some cases sufficient to raise the coal to the temperature of ignition.

Soft coals, therefore, are liable to spontaneous combustion, a danger from which anthracite and coke are free, on account of the absence of volatile constituents. Liability to spontaneous heating depends, to a certain extent, on the size of the coal, the method of storage, and local conditions, such as the proximity of boilers. Both to avoid the danger of combustion and to prevent loss of heating value, the storage of soft coals under water or in dry closed rooms is widely advocated.

In the case of lignite briquettes, now used extensively in Europe for domestic and industrial purposes and to a limited extent in certain sections of the United States there is an important additional element of danger in the heat generated in the briquettes by the high pressure to which they are subjected in the briquetting press. The liability of lignite briquettes to spontaneous combustion has been the subject of extended investigation at the Imperial Testing Laboratory at Gross-Lichterfelde, Germany. The results tend to show that in piles of moderate height, not exceeding 13 ft., the danger of serious heating can be avoided by proper arrangements for ventilation of the piles. In one test 2 piles of freshly made briquettes 13 ft. high, one provided with a central air vent and the other built solid, were observed in a closed room over a period of 6 weeks. In the ventilated pile the temperature did not rise appreciably above that of the air; in the other a temperature rise of 194.4 deg. F. above air temperature was observed.

Subsequent tests showed that occasional irrigation with water has little effect in keeping down temperature. It is concluded that under all conditions in piles not exceeding this height, the danger of spontaneous combustion of lignite briquettes may be removed by permitting free access of air to the piles.

For piles more than 13 ft. high no conclusions are drawn. In all cases, however, the first condition of safety is that the briquette should be thoroughly cooled before being placed in storage.

BROTHERHOOD IN THE PLANT

A New Organization for Power Plant Workers, with Some Old Features and Some New Ones

By John A. Levy

PRESENT day conditions make the requirements, aims and ambitions of all power plant men very much the same and, naturally, the organization which can serve the best interests of all, is one which takes in all the men in the plant. Such an organization has already been established and is growing under the very appropriate name of The Brotherhood of Power Workers. Its membership extends over several counties of western Massachusetts, with headquarters at Springfield, and although comparatively in its infancy, it has come to stay. It was organized Sept. 9, 1910, with 16 members, and voluntary contributions from the members were necessary to defray the first month's expenses; but now it has 115 members and the money in the general fund exceeds $300 besides the death benefit fund, which of course is one dollar for each member, and is ready for immediate payment to the beneficiary of any deceased brother, after which assessment notices are sent to the members and the fund at once replenished.

At first it was misunderstood by those who knew about it, and misrepresented by those who knew nothing about it and so had to start against considerable opposition, but this changed to curiosity and then to inquiry and investigation until now every meeting adds new members and the longer they come the faster they come.

The Brotherhood of Power Workers does not act between a member and his employer, unless the member asks for assistance. The grievance committee then makes an investigation and if the complaint is justified, the committee interviews the employer in behalf of the member, the method of procedure being tactful arbritration and, if that fails, the member is called out and all others keep away from his job.

The Brotherhood, while it is an independent organization, is not opposed to other engineer's and firemen's organizations, and has provided for the fine and expulsion of any member who takes the job of any organized worker who is out for better conditions or more pay. It does not ask a uniform wage, demand the signing of contracts or that only Brotherhood men be employed in any particular plant, in short, it has eliminated everything that would cause needless friction between its members and their employers.

Members as individuals, however, and the organization are doing all they can to impress upon the employers the fact that cheap men in the power plant are even more undesirable than cheap machinery and supplies, and also that after 8 hr. of power plant service a man is comparatively overworked and less able to cope successfully with an emergency. This is particularly true in the boiler room where the maximum of physical exertion is demanded and at the switchboard where the nervous strain is great. The Brotherhood has a well established employment bureau free of charge to both members and employers, thus protecting its members against employment office sharks. This may seem like a harsh word but a personal experience which I had with one will warrant my using it.

It has a system of educational work, which not only makes its members feel that they cannot afford to stay away from the meetings, but makes them feel amply repaid for attending. A question asked by a fireman, is taken up, discussed and explained with just as much interest and precision as if it was asked by his chief engineer.

There is an examining board of 3 first class engineers, who examine prospective applicants for license, and they are repeatedly coached and examined until considered competent to secure license. The Brotherhood pays a sick and accident benefit of $5 a week. Two brothers have been taken away by death and the death benefit paid and while I have no knowledge of the financial circumstances in one case I know that in the other case the benefit was a Godsend.

To raise the efficiency of all power workers to secure a wage, short working day and working conditions which are their due, and to establish an insurance fund which will bury the dead and care for the sick and disabled members, is the work of this organization. Every man employed in the generation and transmission of power is eligible for membership, no distinction being made because of nationality, race, creed or color; but a man's character, habits, and record as a power worker are rigidly investigated the aim being to build up an organization of men who deserve the respect and confidence of their employers and who can be depended upon to do the square thing by their brother man and the organization.

When a man is initiated he pays $3. One dollar goes into the death benefit fund, 50 cents pays his dues for one month, and so the real initiation fee is only $1.50. The dues are 50 cents a month.

As a charter member of the Brotherhood of Power Workers I wish to urge upon all power workers, the need of getting together and organizing with us for a higher standard of living. Organization along these lines extending throughout the country, coupled with Federal license laws is what we need.

Any additional information in regard to organizing, etc., will gladly be furnished upon application to our corresponding secretary, C. C. Harris, 89 Hall St., Springfield, Mass.

COLORS USED TO DISTINGUISH PIPING SYSTEMS

AT one large new Canadian factory the flanges of all pipes are painted so that any pipes may be at once distinguished. A blueprint with the key to the colors, framed, hangs in the power house.

Live steam—All white.

Steam to heaters, also exhaust lines—Pipe white, flange black.

Return from heaters—Pipe white, flange red.

Sprinkler lines—All red.

Hose reel lines—Pipe red; flange white.

Cold water lines—All black.

Drinking water lines—Pipe black, flange white.

Hot water lines—Pipe black, flange red.

Sanitary drains—All green.

Air lines—All yellow.

Gas lines—Pipe yellow, flange black.

On pipes having no flanges the couplings are colored as flanges. Small pipes have a 3-inch strip of flange color every 16 ft.—Canadian Manufacturer.

The growth of a plant depends on the growth of men—with energies properly directed. And it is the man in charge who should view all operations with unbiased judgment, to whom this task of directing belongs. The intelligence of his employes is ready and waiting, and he uses it to make or to mar.—The Sawyer.

LETTERS DIRECT FROM THE PLANT

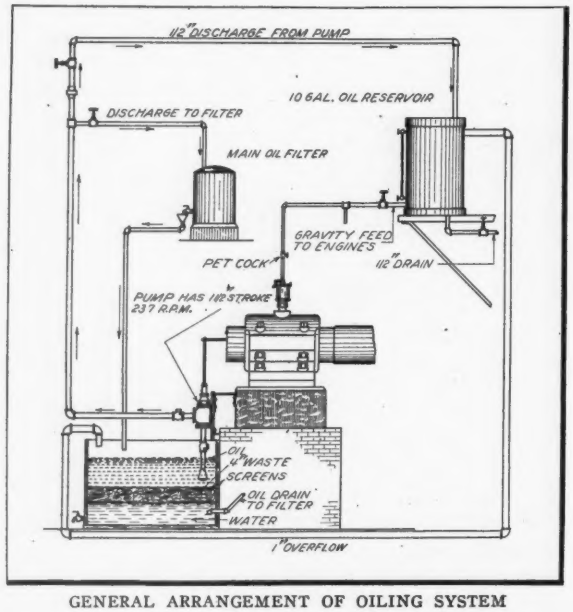
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

OILING SYSTEM

I MADE this oiling system from scrap material I found around my power plant. I capped both ends of a 10-in. pipe 36 in. long, for a tank and fitted it with a gage glass and gages that were once used on a boiler. I mounted it above the engine on a wooden platform and piped from it to the different oil cups on the engines, with pit cocks above each cup.

Next I lined a wooden box, 20 by 12 by 12 in., with galvanized iron and soldered all seams, making it water tight. I placed a screen 4 in. from the bottom, then I packed in 4 in. of clean white waste, and another screen, as shown in sketch.

The oil drains from the engines are carried in by gravity below the first screen, and are filtered through water and then through the waste bed and are ready to be pumped back into the tank above, making a continuous circulation, and the oil is always clean before being used the second time.



GENERAL ARRANGEMENT OF OILING SYSTEM

Next I drilled and tapped a 5/8-in. hole in the end of the main shaft of the engine 3/4 in. from the center, and fitted it with an extended crank pin of 3/4-in. machinery steel.

I made my pump of a 1/2-in. Featherstone angle ammonia valve which I found in the scrap heap. I put it in a lathe and bored it to 3/4 in. diameter and fitted it with a piston and connecting rod, then with the aid of 2 check valves which I had, I got the pump and system working to perfection.

The feed tank is equipped with an overflow which passes back to the filter. Once a week I bypass all oil into the main filter, by doing this the oil is always clean, and I never have any trouble with the cups and pipes choking up.

This system cost my employer $1.05 for new material, 6 1/4-in. pet cocks, 4 1/2- by 1/4-in. tees and 2 1/2- by 1/4-in. ells. It has saved me any amount of labor and gives my engine, which is a high-speed Buckeye, plenty of oil, especially on the main journal, which had previously given plenty of trouble through lack of oil. I now have a small stream of oil running on the bearing direct from the tank and my troubles have disappeared.

E. J. Newman.

DAILY INSPECTION OF PLANT

IT is a very commendable practice, in making daily inspection while on watch, to go into every part of the plant if possible, and take notes on the necessary repairs required about the engines, dynamos, pumps, pipe lines, etc. These notes should be incorporated into a report, dated and made in duplicate, and the original copy sent to the chief engineer, the superintendent, or the manager, as the case may be. This is an important precaution, for a verbal report is absolutely without value as a matter of protection in the event of any question being raised. Moreover, it emphasizes the fact that you are taking care of your employer's interests in the operation of the plant, by exercising due diligence in the matter of cleanliness, simplifying attendant duties by the application of system, and thus reducing the cost of operation and relatively increasing the percentage of efficiency. And it may be added that this will go a long way toward keeping out the central plant.

In some plants there are only certain hours or days during which the required repairs can be made without disturbing the operation of one or more parts of the plant. This is one of the reasons why a trip through the plant for the purpose of noting irregularities should be made at regular intervals.

One good reason for making a duplicate of the report is the possibility that your superior may not assent to the necessity of the repairs. In this event, you may find it convenient at some date to produce the duplicate report to clear your own skirts of a charge of dereliction.

Lewis A. Danner.

DOES THE INDICATOR LIE?

IN regard to this I wish to say that the indicator can be made to show untrue conditions if not properly handled. Any 10 yr. old boy that has ever seen an indicator used, could connect it to an engine and take a diagram, but that would not necessarily mean that he had a correct one, or that he would know what was the matter with the engine after he had taken it.

In order to get a true diagram of the work done in the cylinder, the operator must thoroughly understand the indicator and its use and, while I am positive that the indicator does not always give a true diagram, it

is more often the fault of the operator than the indicator. Many times theory and practice show a wide difference, in regard to indicator diagrams.

A writer in a recent issue shows 2 diagrams taken from a single eccentric Corliss engine, which, according to all theory, etc., could not cut off steam later than ½ stroke. He got a cutoff at ⅝ in one case and ¾ in the other and while he asks for answers to the reason or cause he has partly answered it himself in saying "In the first case I fixed one end so it would not pick up making one end do all the work." This would cause the governor to run in a lower position as the speed would decrease and consequently the valve would not unhook but gradually close as the wrist plate moved back, and, in the second case he increased the point of valve closure by increasing the load in raising the back pressure to 15 lb. and, steam was cut off as in the first case by the return stroke of the eccentric, and not by the action of the drop cutoff. The cards shown may or may not be true diagrams of the work, depending on whether they were taken with good intentions or not.

There is also another reason why cutoff could take place later than ½ stroke, and that is on account of the angularity of the connecting rod. With the eccentric set at 90 deg., and no lap, cutoff could take place as late as ½ stroke, but on the head end, when the eccentric has reached the end of its throw the piston has traveled over one-half the stroke. This would be more in some engines than in others as the connecting rods differ in different makes. The writer does not state whether the diagrams were taken from the head end or not but I think they were and had he tried the crank end, he would have got a much earlier cutoff than that shown. J. C. Hawkins.

TROUBLES OF A LICENSED ENGINEER

SOME employers think that if a man starts in with a fireman's license and low pay, he should not attempt to get a higher license. If he does try, and gets it he has nerve to ask for or think he is worth more.

I worked for such a man, and when I got a second class engineer's license he let me go rather than increase my pay. I got another job and he got a non-licensed man. You think this is impossible in the state of Massachusetts, well it isn't, where the owner has a license to operate the plant.

Everything went well for a week or so and every time I met my old employer, he told what a good man he had. After a month this man called me up on the phone and asked me to come up and see what was the matter with the boiler. This plant consisted of a Manning boiler and an Atlas engine in a saw mill. The boiler making steam for a dry kiln and to run the mill, which kept the boiler going up to its capacity and over too. Its being loaded so and taking water from a mountain stream, necessitated careful and frequent cleaning.

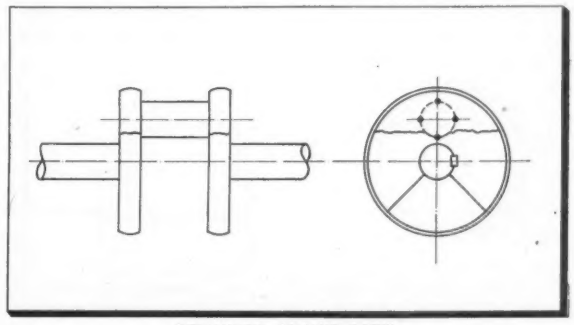
When I got there the sheet was bulged in the fire box, just above the furnace door. I warmed it up with a blow torch and pounded it back. There was a small hole in the center, I drilled this, tapped it for ¼-in. plug, screwed in the plug and sawed off level with the plate, took out the hand plate above the door and removed the accumulation of mud and scale and, after showing this good cheap man how to clean and keep clean a Manning boiler, I told him to notify the inspector before he got pressure on, and started for my own job.

But the next day I had to go again, he filled the boiler with water and started a fire under it and went home for supper, his home being a short distance. When he got back he found the hand hole plate had leaked so badly while he was gone that it let all the water run out onto the floor and burned out the safety plug.

His boss didn't send for me because he thought the tubes were burned, oh no, but because he could not find the safety plug and did not know what the matter was, when the water he put in ran out through the plug and put the fire out on one side so he could not make steam.

I took out the plug, refitted it with lead, all I could find, put it back in and filled her up with water.

After getting her going I asked him what the inspector said about the bulge and my treatment of it



REPAIRED CRANK DISK

and if he reduced the pressure which was 125. He told me the inspector pronounced everything O.K., and the pressure was to remain the same. Then the fireman told me he had never notified the inspector.

While I was tinkering with the plug I noticed the boss pounding on the crank key with a large hammer. After we got steam up he warmed up the engine and opened the throttle. She made half a turn and then the crank disk split as per sketch. We had to take the shaft out, take the balance wheel off one side and make a strap and shrink it on the disk. After doing this the crank pin was a little loose so I drilled four holes in and tapped them out, then screwed four ¼-in. set screws in and sawed them off flush with the disk.

After doing all this I charged him $10, but he said it was too much. He offered to let it go and he would give my job back with a raise of 25 cents a day. This only made $1.75 and I was getting $2.50 where I was, a better job and boss. I declined and sued him for $20.00, which I got. Now we don't speak as we pass by. John Kimsley.

PUMPING WATER BY MEANS OF COMPRESSED AIR

IN the June 15 issue of Practical Engineer I notice that N. F. S. asks why compressed air cannot be used to raise water from 150 ft. well. In answer I wish to state that there is no reason that it cannot be done if rightly fixed.

The writer knows of several wells being flowed by air. It is very common in some parts of the country. Water companies find it more economical to flow the wells into a tank and allow the water to flow from tank to pump, doing away with the lift, which amounts sometimes to 15 or 18 in. vacuum.

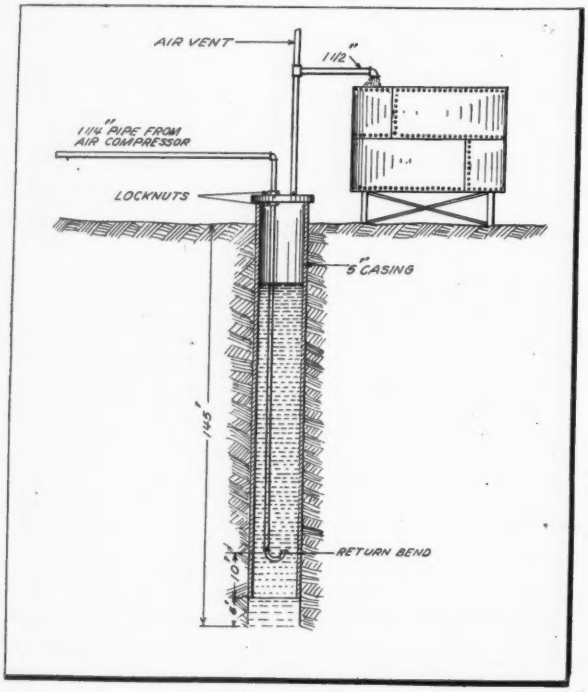
Where you flow a well with compressed air you must figure on the amount of water that the well

is able to produce, i.e., per minute, according to your diagram your casing is 150 ft. or sets on the bottom of the well, which is wrong.

Then you have 25 ft. of water at atmosphere pressure that would give you 12 lb. per sq. in. at the bottom. Now the point is that you must not have your casing within 5 ft. of the bottom and your air pipe within 10 ft. of the bottom of casing, and, if connected according to the accompanying diagram, you will not force water back into the ground or you will not need to shut down your compressor.

Another thing I wish to state, according to your drawing you have your water line entering the bottom of your tank, which, if you did not have a check valve, would mean that the water would run back into the well when the compressor is stopped. The drawing that I submit is of a well that is in daily use at the Tima Refining Co. plant.

Compressed air is not alone used for flowing water wells, but is largely used for flowing oil wells in this part of the country. I think if N. F. S. follows my



AIR LIFT WELL

plans he will not have very much trouble.

The plan which I give is operated at 50 lb. air pressure, using 70 cu. ft. of free air per minute. It runs day and night without any trouble. All fittings must be tight and casing well secured.

L. E. Conroy.

AIR LIFT WELLS

ON the questions and answers page I saw a drawing of an air lift with the initials of N. F. S. signed under his question. I would say it is a very poor style of lift. I have been working a 4-in. lift line in a 400-ft. well, the water coming within 15 ft. of the surface level, and I have never seen it any lower than 27 ft. from surface.

First lift is down 80 ft., but does not give satisfaction and wastes the air. Second lift is down 180 ft. and with 100 lb. air and a 1-in. globe valve just barely cracked will throw 300 gal. of water per minute. I have been working this well every summer for 5 yr. We have a 320-ft. lift, but have never used it, as we could get sufficient supply from second lift.

I will enclose a rough drawing to give N. F. S. an idea how they are constructed and would state that

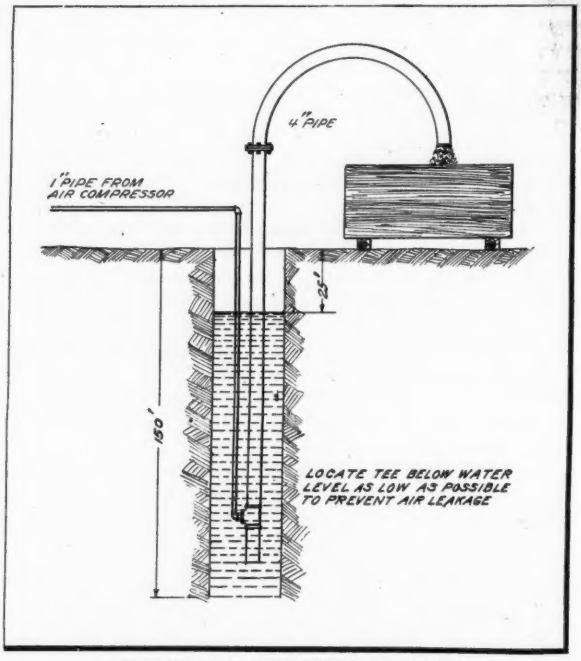


DIAGRAM OF A SUCCESSFUL AIR LIFT

he should have his discharge pipe flow into the top of tank with 3 to 4 in. between end of pipe and top of tank as per sketch. A. W. B.

BRUSH TROUBLE

ONE of the most elusive causes of trouble with a direct current generator or motor is incorrect brush position. The brushes may not be displaced far enough to cause serious sparking but still produce abnormal running conditions.

There appeared not long ago in the columns of Practical Engineer an article explaining "failure to build up" on account of incorrect brush position. This is quite a common occurrence if the brush rocker is of such construction that it can be easily displaced.

Since this article appeared I have noticed 2 instances where displaced brushes caused trouble. One was the case of a 200-hp. 240-volt direct current motor. Without apparent reason it became afflicted with a tendency to run away. The machine behaved very properly on a small load, but when the load became heavy it seemed as if the fields lost their magnetism, the motor would take an excessively high current, and frequently the breaker would open.

The cause was found to be as follows: The brushes were shifted by means of a hand wheel with a long screw, the common device for this purpose. The nut in which this screw worked was pivoted to the yoke, and a ring on the brush rocker worked between 2 collars on the screw. The pin in one of these collars had sheared off and the rigging slipped backwards as far as the cable would permit. Simply pushing rocker rigging forward and pinning the collar back into place cured the trouble.

The second instance was the case of a 25-kw. interpole generator compound wound. It was being tested,

a water box or rheostat being used for load. Everything went smoothly for a while—when without any apparent change in conditions the load began to increase and the voltage to rise. The breaker was tripped and the line examined for partial grounds, but none was discovered. When the breaker was closed the machine "grabbed" the load so much that the driving motor belt came off. The trouble was found to be the accidental shifting of the brushes back of neutral. This seemed to cause the commutating poles to act as series coils and cause the machine to overcompound very much. The greater the load, the higher the voltage generated, and this in turn produced a still greater load, and so on. The limiting point was not within the capacity of the driving motor.

It is well to have the neutral point permanently marked on all d.c. generators and motors. The best running position should also be marked, a center punch mark will do. "Do it now."

The neutral point can readily be determined as follows:

With machine standing, separately excite the generator field. This can be easily done by running light wire to an exciter or similar source of current. Have enough voltage across the field terminals to produce a fairly bright flash when the field switch is opened. Connect a low reading voltmeter across the armature, one with a range of say 5 volts. When the field is broken, the voltmeter needle will "kick" in one direction and when the field is made in the opposite direction. This is due to the charging and discharging of the magnet poles, causing lines of force to cut the armature coils and induce a slight voltage in them. Have a helper turn the handwheel shifting the brushes or change them in the proper manner. As the brushes are moved, the "kick" of the needle will change in violence. When "neutral" is reached the kick of the needle will have entirely disappeared and no amount of making and breaking the field will produce any effect on the voltmeter.

V. E. J.

SECURING PISTON ROD

WHEN I read Student's letter on page 583 of Practical Engineer I did not think I could tell him, from experience, what he should have done under the conditions he names, but now I can tell him what I did do under similar conditions which recently occurred.

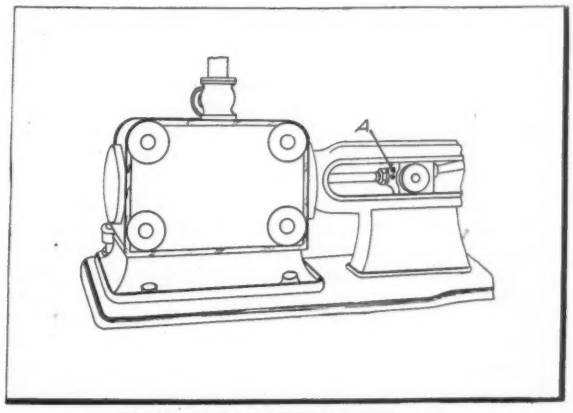
Our engine is a 20 by 36 by 42 in., cross compound, condensing Corliss, running at 81 r.p.m. Our cross head is of the box design, the high pressure piston rod is 3½ in., screwed into the crosshead 6 in., with a lock nut on the outside the same as Student's.

Monday I noticed a strange noise in the crosshead, and as it grew louder I shut down and found the lock nut loose and the piston turned around one turn. I have marks on the crosshead and rod so I can tell with the dividers if the rods have moved or not. The thread on the rod is V-shaped and runs 8 to the inch and as the clearance in this cylinder is just ⅜ in., one can see by the rod making one turn that one-third of the clearance was gone.

So after getting those points through my head, I turned the rod back to its proper place and tightened up the nut, using a heavy wrench and sledge to do so. I started up again, but had not been running 2 hr. when the same noise started again. Of course I wanted to make sure there was a cause before shutting down.

While deliberating I heard a faint knock at the back head. Then I knew the time limit was up, so instead of running around and attempting to close the throttle, I grabbed the governor lever and pulled the governor to its lowest position. Then bringing the safety cams under the hook rolls prevented the hook from hooking up the steam valves, and as the engine was carrying her maximum load, she was stopped before I had the vacuum pump cut off.

She stopped on the back center and we took off the head and found the follower had bumped until it left



METHOD OF SECURING PISTON ROD

a mark all around. We wanted to take the rod out of the crosshead and examine the threads, so I started ahead from the low pressure side, so we would not back the piston out enough that the rings, which are sectional, would drop down the exhaust port. We found the thread on the rod all right, but that in the crosshead was not so good and the lock nut did not come square up to the crosshead, so we faced it off true.

We were stopped 2½ hr. doing this, but just as soon as Sunday comes we are going to drill a ⅜-in. hole through the crosshead and rod at A (see sketch) and put a bolt in with a nut at one end and a taper fit at the other. It is either this or a new rod or crosshead. The fit between the 2 is so bad that it would be tempting fate to run them as they are.

A. W. Griswold.

MAKING IMPROVEMENTS AND REPAIRS ABOUT HEATING PLANT

IN order to obtain the highest efficiency, an operating engineer of a heating and ventilating plant must have some knowledge at least of the piping of steam lines; as winter will soon be coming, the heating system should be overhauled and modified, using notes taken during the winter months as guides for making any necessary repairs about the piping, renewing of gaskets in leaky unions, and repacking the stuffing boxes of the various types of valves. Or, improvements such as the placing of tees for the purpose of installing of air vents at the highest point for relieving the heating system of any accumulation of air, which may be confined there under pressure. Also, the draining of the system at its lowest point, having the piping sloped towards the vented receiver, as this question of proper drainage is always an important one and should never be overlooked.

Relieving the heating system of its air and providing proper drainage will help to increase the activity of circulation in the water of condensation. If this same water could be returned to the boilers as soon as possible the moment the steam becomes condensed, without loss of heat units below the evaporation point, it means a saving of fuel and increased capacity of boilers. An approximate

saving of 1 per cent in fuel is effected by each increase of about 10 deg. in the temperature of the feed water. The return lines should be covered with some good non-conducting material to prevent loss of heat by radiation; this practice should be carried out as results justify.

I have knowledge of an instance where the heating plant had a poor arrangement of piping, and the system was always becoming air and steam bound at irregular intervals, making a slave out of the firemen. To overcome this difficulty in operating the system continuously, the following improvements were made.

First, venting the receiver to the atmosphere relieved the system of its back pressure. Second, using an ejector condensed the vapor and formed a vacuum on the returns of the heating system by using make-up water flowing continuously through the ejector nozzle. Third, lowering the boiler feed pump below the receiver allowed the water, which was very hot, to gravitate to the pump under pressure, as by this arangement it is possible to maintain a better vacuum in the receiver. A constant water level was maintained in the receiver.

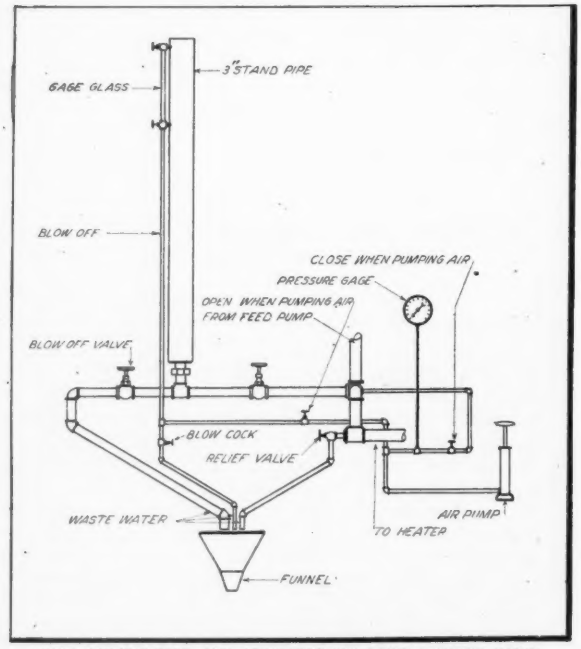
One remarkable feature, after making the above improvements, was the heating plant operating costs, as there was hardly any difference in the maximum or minimum amount of fuel consumption, after atmospheric temperature had reached the freezing mark, or even as far as the zero mark, the direction or velocity of the wind made little difference in fuel consumption.

L. A. D.

STOPPING POUND IN PUMP

I THINK that Thos. C. Robinson's idea of the pump pounding is a good one. I had the same trouble with my pumps pounding and slamming the checks down.

Our pump had been doing this for 10 yr. The chief engineer could not make out the trouble. I was the night engineer at the time, and told him if he would put an air cushion stand pipe between the heater and his feed pump, it would not only do away with the pounding but would do away with the bursting of the tubes in the heater also.



CONNECTION FOR AIR CUSHION OF FEED WATER LINE

He thought I was wrong, so he let the trouble go on, and about every month or 2 we were compelled to put new tubes in the heater.

Last spring I was made chief engineer of the plant, and I have now overcome the trouble in the following way:

I took a piece of 3-in. pipe 8 ft. long for the stand pipe, my feed pipe was 2½ in., and placed it between the feed pump and the heaters for an air cushion stand pipe; about 1 ft. from the top, I put in a water glass and connected it with a large auto pump.

I pump the air through the glass into the stand pipe. Since I put this up I have done away with all that trouble.

Frank Bohl.

BLOWOFF COCK LEAKAGE

ON the blow down pipe, our asbestos packed plug-cock had been replaced several times; each one appeared in good condition and tight when first put in but within about 6 weeks had commenced to leak, which increased to such an extent that a new one was put in again.

Investigating more closely, we found the cause; the night engineer said that when blowing down the boilers he opened the cocks only part way, which accounted for the wearing away of the asbestos, while, if the cock had been opened wide while blowing down the boilers, the asbestos would be protected on all sides of the opening.

He also said that "when I open them gradually the plug sticks, because it expands, so I let it remain part way open." Of course it would be only natural for the plug to stick, but if he had opened it all the way after it was warmed up, the trouble would not have occurred.

Since the present cocks have been put in, which was over 3 yr. ago, no further waste or expense has been had in that line. When the boilers are cleaned, the plug in the blowoff cock is removed and a mixture of graphite and cylinder oil is applied.

J. G. S.

FEED PUMP RELIEF

FOR some unknown reason the boiler feed pump was much too large for the boiler and could only be run at intervals. A smaller pump was suggested, but would not be considered at that time, so a bypass and globe valve were put in near the pump connecting the suction and discharge.

This valve in the bypass was adjusted so that the speed of the pump could be regulated to run continually. A thermometer was put on the feed line near the outlet of the heater, which showed that the desired results were obtained, and by this change the water had a sufficient time for purifying and to get hot while passing through the heater.

Besides, the pump packing had not to be renewed as frequently as before, there was always a constant and regular supply of steam gained, and when the boiler was again opened up for cleaning, a perceptible difference was noted in the accumulation of mud and scale, hence, a large saving was in evidence.

James G. Sheridan.

CALIFORNIA No. 4 of the N. A. S. E. was organized recently at Los Angeles and the following officers were elected: W. H. Russell, president; J. S. David, corresponding secretary; E. F. Jackson, vice-president. The address of the secretary is Hall of Records engine room, Los Angeles. The association is a live one and fills a long felt need in the community.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Two Handy Devices

ACCOMPANYING illustrations show 2 handy devices for use in the engine or boiler room. Fig. 1 is an arrangement for raising and lowering manhole plates. The plate is drilled for a ½-in. loop or eyebolt

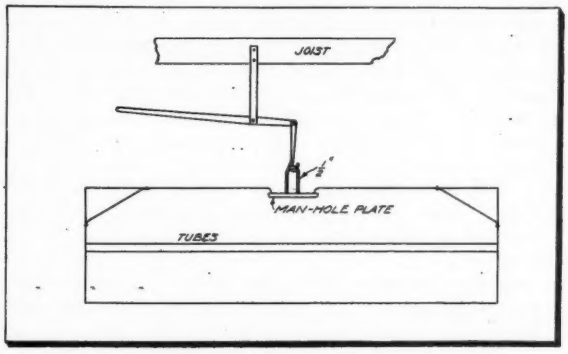


FIG. 1. DEVICE FOR HOLDING MANHOLE PLATE

and the levers are made of ½ by 1½ in. iron. The manhole plate cannot only be raised and lowered, but it can be held securely in place while the crabs are

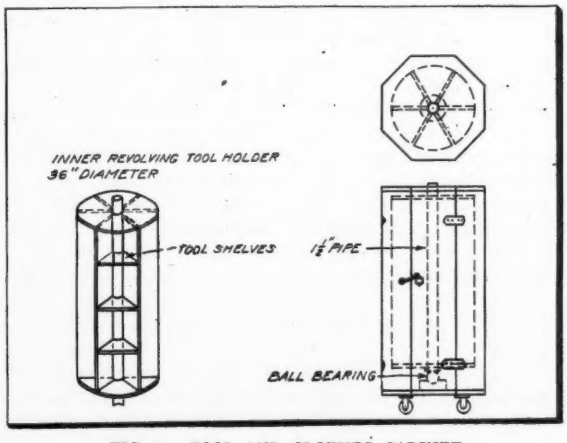


FIG. 2. TOOL AND CLOTHES CABINET

being fastened. If a small weight is attached to the lever at A one man can do all the work.

Figure 2 shows the details of a tool cabinet and clothes holder. W. D. Bippus.

Home-Made Bench Drill

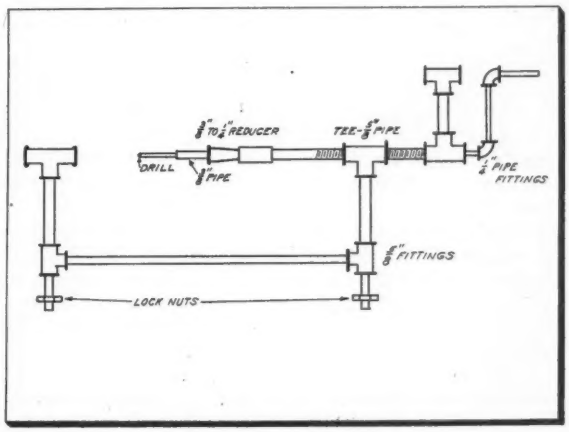
I AM sending a drawing of a bench drill made out of pipe fittings. The size of the pipe fittings used to make it will depend on how large the work you intend to drill with it.

The feed screw can be made either long or short as you want it. The spindle is made of ¼-in. pipe and fittings, it also makes a crank.

At the end of the feed screw there is a brass bushing which reduces the ⅝-in. pipe down to ¼ in. I bored the threads out clean so that the spindle will turn easily.

The chuck is a piece of ⅜-in. pipe bored out so that a ½-in. shank drill will fit into it; then heat the pipe and put the drill shank in the pipe and flatten it to the shape of the drill. This will keep the drill from moving when in place.

The tee handle on the feed screw is for turning it to feed the drill to the work. The lock nuts at the



HOME-MADE BENCH DRILL

ends are for fastening the drill to bench or plank; just bore 2 holes and put the pipe through them, then screw the lock nuts up snug.

Maurice W. Epperson.

A CHANCE FOR THE INVENTOR

WHILE the present fountains are designed only for service in city and village schools having water pressure, yet it is to be hoped that someone will contrive some sort of apparatus that will give to the country boys and girls what their city brothers and sisters have at present —an opportunity to get a drink of fresh, clean and uncontaminated water.

At present few country schools have wells on the grounds. Water has to be carried from the nearest farm house, and therefore must not be wasted. Consequently the children are usually drinking stale water which has stood in an open bucket which has received not only the drippings from a leaky dipper in the hands of the pupil, but also the water remaining in the dipper after the pupil has drunk his fill. He who will design apparatus to correct this unsanitary practice will deserve well of mankind. —Valve World.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

Troubles That Never Come Singly

MY DEAR FATHER:—

You will remember that when I left The Bergville Technical Institute, that you told me in one of your letters that "trouble comes to everybody sooner or later." Well, I thought that while you are my father and entitled to all the respect that it is possible to give you, that possibly you might be mistaken.

Now I find out that you were right and that it not only comes to a fellow some time or other, but that when it does come, it seems to lose its return ticket and camps with you for quite a while. There is an old saying that "troubles never come singly but in battalions."

Well, I am convinced now that battalions is altogether too small a word. It ought to be a whole army, at least, you see father, it was this way. Fred who had been in the hospital for some little time after he dropped the gratebar on his foot, came around and saw to it that he drew his money during the time that he was disabled, meanwhile looking around for another job.

One day the Chief asked him when he was coming back to work, in a tone of voice that implied that he would just as soon that Fred never came back. Well, Fred "allowed" that he wasn't coming back, so that was all there was to it. Fred left and I got the position as head fireman (and the only one), at The Daneberg Mfg. Co.

But that is not part of the bad luck—except that it might be so classed as part of the bad luck that seemed to be following Fred. At any rate things went along smoothly for a week or 2 till I had made up my mind that it was time to write home again. Then the black cat came back.

We have 2 feed pumps supplied with steam by a common pipe which divides at the pumps making a very nice arrangement. These pumps are of a size large enough to supply twice the present boiler capacity, but that day as I was thinking what I was going to write, suddenly the low water whistles began to "cheep," although the pump seemed to be working as usual.

The water seemed to hang around about 2 inches above the bottom of the glass and there it stuck, neither gaining or loosing. As soon as the foundry blower went off at 5:30, or so, the water began to raise so that by 6 it was normal.

I told the Chief about it and he mused awhile and finally concluded that it was something in the valves of the pump, so we changed pumps. Next morning, about 7:30, the same thing happened again, only that the water gradually went down till it seemed to be time to draw the fires, when suddenly it began to go up till it was controlled by the feed-water regulators, and there was no more trouble for 2 days.

Then it all began again, and to save our lives, we could not seem to locate the trouble. The Chief got a pressure gage and put it on the discharge line of the pump, and at the time it seemed to show about 20 pounds in excess of boiler pressure as it should. Then just as the foundry blower went on in the afternoon, the evil spirit overtook us again, and while the water never left the glass, yet it kept us guessing as to when it would.

I knew that there was 4 inches over the tubes with the water just showing in the glass so there was a grain of comfort in that. The Chief came down at my request and he really looked troubled, but like a good boss he kept his head. He changed pumps but to no purpose.

Then he got into one of them but found everything all right. So he changed again and dissected the other one—and never swore once. This was Saturday, and by mutual consent we both staid to see what we could find. Taking a plug out of the feed line near the boiler, after closing the master valve, we started the pump and got oceans of water, but of course, at a low pressure.

Then the Chief put a valve on the opening and gradually closed it meantime keeping his eye on the gage. As the valve was closed the line pressure went up till it slightly exceeded the boiler pressure when the water went into the boiler (the master valve being now open).

This was repeated several times with the same result. Then leaving the line in working order, he washed up with a far away look in his eye. We were both on the job bright and early Sunday morning, with steam up in only one boiler of course. We tried our stunts all over again and to our surprise, we had all kinds of pressure in the line.

This seemed to please the Chief immensely, and for the life of me I could not see why till he went and got the tools and began to take down the steam pipe leading to the pump, we first having shut off the line to the dry kilns. It seemed to me to be nonsensical to look for the trouble in the steam pipe for what could get in there?

But the first section that he took out solved the mystery, for on handing it to me to look through as he had done, it was choked up with a scale formation all but a little hole about the size of a lead pencil.

"What do you make of that Mac?" said he and it stumped me completely. There seemed to be no reason why this should be in there as steam was taken from the top of the main and so far as I knew, the boilers never foamed or primed. But there it was all right.

We removed the obstruction after a lot of time had been expended on it and soon had everything together again when we found to our surprise that the feed line pressure was more constant and that it was higher.

Opening the temporary valve on the line the Chief let out about enough water to correspond with the amount used by the other 2 boilers when in commission, but the pressure stayed right on the mark. The problem had been solved. But what caused the obstruction to form in the steam pipe?

In all probability, when the pumps would slow down, it was because some obstruction detached itself from the main body in the pipe and partially filled the hole, which, ever small and getting smaller, was so reduced in area that the steam was throttled enough to reduce the pressure in the feed line to a point where it was not sufficient to supply the boilers.

That was trouble number one. That same Monday that we started up with the water end repaired, we had trouble with the grates of No. 2 boiler. These are of the time honored double bar variety and it seems that one of them was a little too short. After it was

all over, I recalled that one day when we were short of bars, Fred took an old bar over to the foundry to have a new one cast. Of course, when it was made it was some ¾ in. shorter than the bar it was cast from, owing to shrinkage.

We had taken a bar from No. 2 to use and also to use as a pattern, it being cut out at the time so when the short one was received from the foundry, it was put into this boiler, and, being short, Fred had wedged in behind it with a piece of a brick, which lasted as long as he was on the job. Consequently when I was cleaning the fire Monday morning, as I said, everything pulling hard, as it does on Monday, the short bar fell out and there I was in another boat.

This was an experience that I never had either, at the Bergville "Tech." and I puzzled my brains as to how I was going to keep things hot, for the coal dropped through into the pit as fast as I could put it in. I tried filling the place with big lumps, which worked all right for a while till they fell through, half consumed.

I sent the coal passer for the Chief and when he came in and saw my anxious look, he smiled and said something about, "A smooth sea never making a skillful mariner," and asked for the old grate. Taking the measure of this, he went away whistling as if it was an every-day event, like blowing the tubes, and not giving me a word of advice about what to do.

He came back shortly with a piece of scrap 2-in. pipe and throwing it on the floor, took the poker and soon had the grate bars pushed over to fill the gap, leaving the opening at the side next the brickwork. Then taking the pipe he deftly threw it into the opening, after which he took the long handled shovel and threw some ashes on top of the pipe, and there I was as good as new till we had a chance to cut the boiler out next Sunday and fix it right, which we did.

After the grate bar affair, I was wiping the sweat off my brow in a manner that would have done credit to The Village Blacksmith, when there was a muffled "pop," followed by a hissing roar and a water glass was gone. No sooner had I put in a new one than the one on No. 1 boiler let go, and first thing after dinner the other one let go.

Perhaps it all unnerved me, but I made a mistake and let my shovel go in with a scoop of coal. Luckily, however, it was an old scoop, having handled about 850 tons of coal. From 2:30 p.m., it seemed that the hoodoo was broken, for things were beginning to go exceedingly smooth, so much so that I began to think that it could not last.

I was not far from right, for when I blew the 6 o'clock whistle, it kept right on blowing. When the Chief came in to see what all the demonstration was about, I was busy with the master valve shutting off the steam. The Chief and the assistant stayed that night and fixed it.

Now, how is that for one day's mishaps? Can you beat it? Well, father, it is now nearly 10 o'clock and I must get to bed. I try to make it a point to retire not later than 10, and I think it pays, as I always feel rested when I get up in the morning. A week or so ago, I was invited out to a party and did not get home till nearly midnight and I felt it next day; in fact, for several days.

Oh say, by the way, I met the Chief's daughter at the party. In fact, I took her home. Maybe that is why I stayed out so late. Her name is Hazel, and, father, she is a "peach."

Affectionately your son,

Donny MacDougal.

MODERN PLANT FOR BREWERY

THE Fred Krug Brewing Company, Omaha, Neb., has added a modern power plant, designed by C. A. Chapman, of Chicago. It consists of 4 large water tube boilers, with Green chain grates, arranged to receive coal from overhead bunkers, which will hold approximately 300 tons of coal. The coal will be discharged into a track hopper, which is located over a Joor self feeding crusher arranged in conjunction with a by-pass for slack coal, both of these discharging upon a belt conveyor, which delivers coal inside the basement of the boiler house. The belt conveyor and crusher are driven by a 20-hp. electric motor, and the coal as discharged from the belt conveyor is received into a Joor Pivoted Carrier, which runs the length of the basement and is arranged to receive ashes from the pits underneath the chain grates.

Another feature introduced into the plant is a leveling conveyor for completely filling the ash bunker, which is located between the 2 pairs of coal bunkers, and is arranged to discharge the ashes back into the same cars that bring in the coal. The chute for discharging the ashes to the car folds up flat against the wall, and the flow of ashes is controlled by a valve operated by hand chains from the side of the car.

The coal bunkers are fitted with Joor undercut valves operating over universal bells so that telescoping spouts can be readily handled by one man through all of the movements necessary in delivering coal to stokers.

IN THE UNITED STATES the production of coke in 1911 was less than that of 1910 and below the average for the last 6 or 7 yr., according to a statement by Edward W. Parker just issued by the United States Geological Survey; but a striking and encouraging feature of the condition of the industry was an increase in the amount of coke made in by-product ovens and the incidental conservation of the gas and coal-tar products otherwise wasted. In sympathy with the depression in the iron trade, the total production of coke decreased 15 per cent in 1911, compared with 1910, but the output from the by-product ovens increased 10 per cent, and the increase in the number of ovens of this type in operation was larger than in any other year, with one exception, since they were introduced into the United States.

The total production of coke in 1911 was 35,555,362 short tons, valued at $84,103,571, compared with 41,708,810 tons, valued at $99,742,701, in 1910. The 1911 output consisted of 27,705,517 tons of beehive coke, with an average value of $2.05 a ton, and 7,847,845 tons of by-product coke, with an average value of $3.48 a ton. The difference in price was due largely to the fact that most of the by-product plants are situated nearer to the markets for coke, as well as for gas and other by-products, so that the transportation charges are added to the cost of the coal instead of to that of the manufactured coke.

The beehive ovens produced an average of 466 tons each; the by-product ovens an average of 1817 tons each. At the close of 1911 there were 2254 ovens in course of construction, of which 698 were of the by-product type.

A SOLDER THAT will fuse at a low temperature and used in uniting soft metals is made by adding 3 drops of mercury to each ounce of common solder.—Penberthy Engineer and Fireman.

ELEMENTARY MECHANICS

Problems in Motion, Velocity, Momentum and Force Solved Arithmetically and by Means of the Slide Rule

WHEN considering motion we must speak of it with reference to some point which is considered to be at rest. Velocity is the rate of motion and is the number of units of space passed over in a unit of time, as feet per second, or miles per hour.

If the same number of units of space are passed over in each succeeding unit of time, the velocity is uniform; under all other conditions it is variable. As an illustration, assume that a railroad train runs at the rate of 40 miles an hour for 3 hr., its velocity may then be considered constant; but if it runs 35 miles in the first hour, 10 miles in the second hour and 15 miles in the third hour its speed is said to be variable.

If we wish to express that velocity in feet per minute, it is necessary to multiply the distance in miles by 5280, the feet in a mile, and divide the result by 60, the minutes in an hour; or if we wish to express it in feet per second we must divide by 3600.

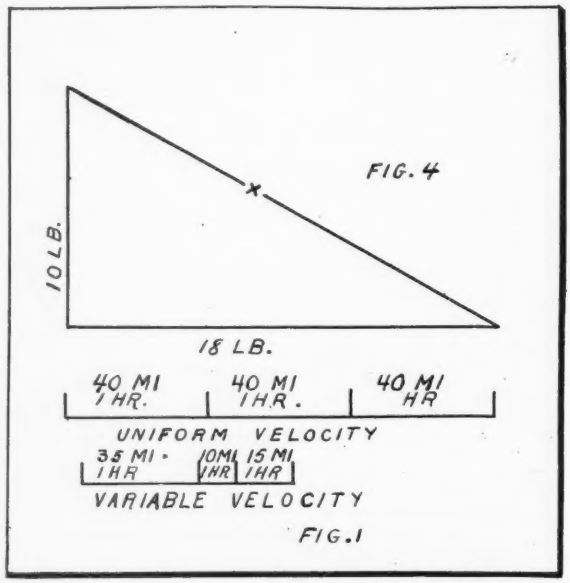


FIG. 1. COMPARISON OF UNIFORM AND VARIABLE VELOCITIES
FIG. 4. RESULTANT OF 2 FORCES BY GRAPHICS

Find the velocity in miles per hour of a train which travels 47 ft. per second. In this example feet per second are given and to find miles per hour we have the following equation:

$$\frac{47 \times 3600}{5280} = 3.2 + \text{ miles per hour.}$$

If any 2 of the 3 factors space, time and velocity, are given it is possible to find the third by the following rules:

Velocity = space ÷ time.
Space = velocity × time.
Time = space ÷ velocity.

The velocity of a point upon the rim of a flywheel is 200 ft. per second. How far will it travel in 3 minutes?

$200 \times 60 \times 3 = 36{,}000$ ft. Ans.

A flywheel 8 ft. in diameter runs at 320 r.p.m., what is the velocity of the rim in ft. per minute?

In this example it is necessary to find the circumference of the wheel which is equal to 3.1416 × diameter. Then the diameter, 8 ft. × 3.1416 = 25.13+ ft. As the wheel revolves at 320 r.p.m., the velocity per minute = 25.13 × 320 = 8041.6 ft.

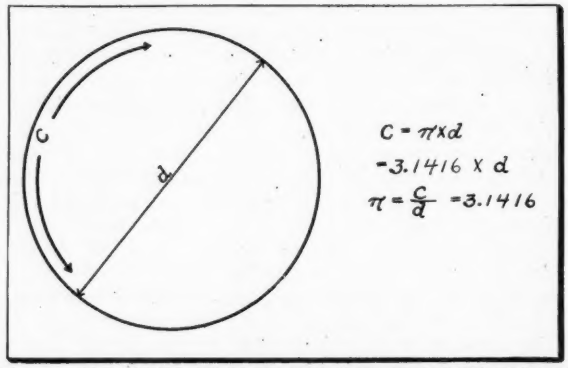


FIG. 2. THE VALUE OF PI OR RATIO OF CIRCUMFERENCE TO DIAMETER OF A CIRCLE

On the slide rule 3.1416 is denoted by a long scale mark on the left-hand A scale, and is marked pi. Set the left-hand index on B scale under 3.1416 on A and over 8 on B find 25.13+ the circumference of the wheel. Bring left-hand index B under this product and over 320 on B find 8041.6 the velocity of the rim in feet per minute.

Momentum

MOMENTUM is equal to the quantity of motion and is the product of mass and velocity. In a given time twice the motion will be given to a body by 2 units of force that will be given by one unit. For example, the momentum of a mass weighing 100 lb. with a velocity of 50 ft. a second will be equal to the momentum of a mass of 50 lb. with a velocity of 100 ft. per second. Equal forces acting on equal bodies produce equal momentum.

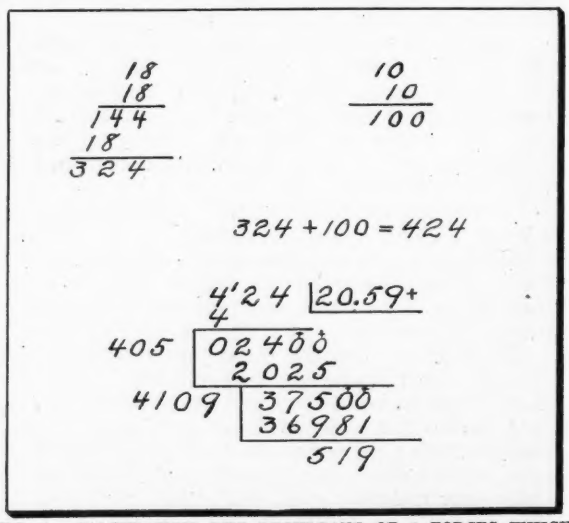


FIG. 5. CALCULATING THE RESULTANT OF 2 FORCES WHICH ACT AT RIGHT ANGLES

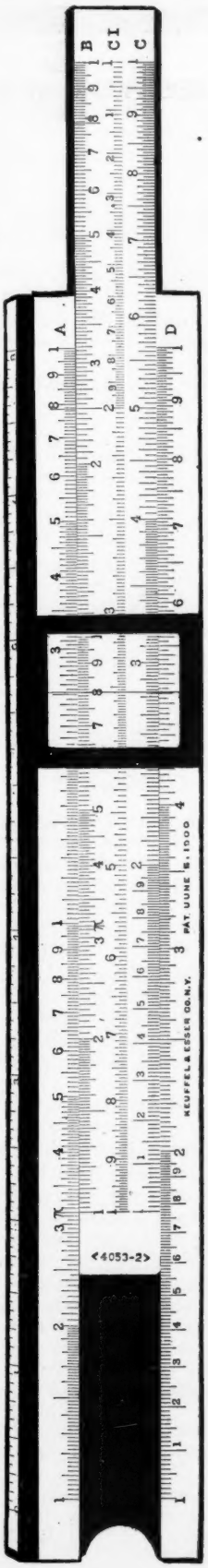


FIG. 3. CALCULATING THE CIRCUMFERENCE OF AN 8-FT. CIRCLE

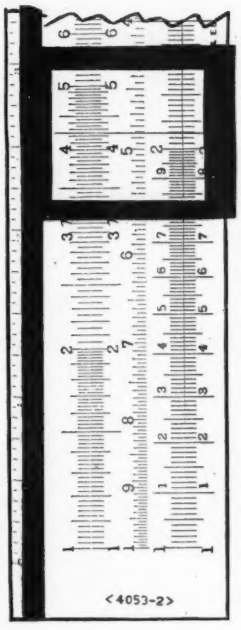


FIG. 7. EXTRACTING THE SQUARE ROOT OF 424 ON THE SLIDE RULE

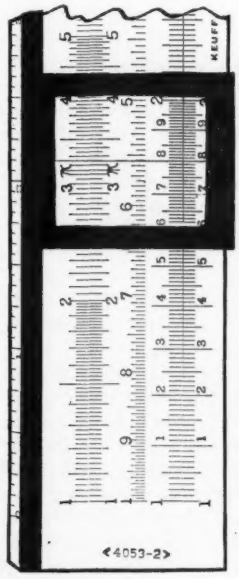


FIG. 6. SQUARING 18 ON THE SLIDE RULE

Two bodies weighing 75 and 150 lb. respectively have equal momenta. The first has a velocity of 200 ft. a second, what is the velocity of the other?

We have already seen that momentum is the product of mass and velocity. In the example we have a body weighing 75 lb. with a velocity of 200 ft. a second and we wish to find the velocity of the body weighing 150 lb. which has equal momentum. The momentum of the first body $= 75 \times 200 = 15{,}000$, then the velocity of the second body $= 15{,}000 \div 150 = 100$.

This example is better worked out by proportion and may be stated as follows:

$75 : 150 :: X : 200$. Multiplying extremes and dividing by the mean gives $75 \times 200 \div 150 = 100$.

To perform on the slide rule the operations involved in proportion, set the first term on the C scale opposite the second term on the D scale, then opposite the third term on the C scale read the fourth term on the D scale, when the fourth term is to be found. If the third term is wanted find the fourth term on D scale and above it on C scale read the third term.

Place 75 on C scale over 150 on D scale and over 200 on D scale find 100, answer. For locating the decimal point use approximate cancellation. In this particular example the numbers cancel exactly, but in the majority of problems they do not, therefore the slide rule performs the operation of proportion much more rapidly than can be accomplished arithmetically.

A piston weighs 600 lb. and has a momentum of 11,000, what is its velocity per second? $11{,}000 \div 600 = 18.33$. Ans.

Place 6 on C scale over 11, on D scale and under the index on C scale read 18.33 on D scale.

Force

FORCE signifies any cause which tends to produce, change or destroy motion. Assume that 2 forces with a magnitude of 18 and 10 lb. act on a body at right angles, what is the resultant motion?

The resultant, X, may be graphically represented as the third side of a right triangle whose sides adjacent to the right angle are 18 and 10 respectively, as shown in Fig. 4.

The third side of a right triangle is equal to the square root of the sum of the squares of the other 2 sides.

Let X^2 represent the resultant.

Then $X^2 = 18^2 + 10^2 = 424$.

$$X = \sqrt{424} = 20.59+.$$ See Fig. 5.

For the slide rule, place runner over 18 on the D scale and read 18^2 or 324 on A scale. To find the decimal place take the nearest number having a cipher, which in this case is 20, and multiply mentally, obtaining 400, or 3 places to the left of the decimal point. The square of 10 is computed mentally. Adding 324 and 100 we have 424. To extract the square root place the runner over 424 on the right hand A scale and on D scale find 20.59+. When the number of units in a number is even the right hand A scale is used, when odd the left hand A scale is used. In extracting square root, to find the decimal point divide the number into periods of 2 figures each, left from the decimal point, thus: 4'24. Then the root will contain as many figures left of the decimal point as there are periods in the number.

RED LEAD CEMENT for face joints can be made of 1 part of white lead, 1 of red lead, mixed with linseed oil to the proper consistency.

Questions Answered and For Answer

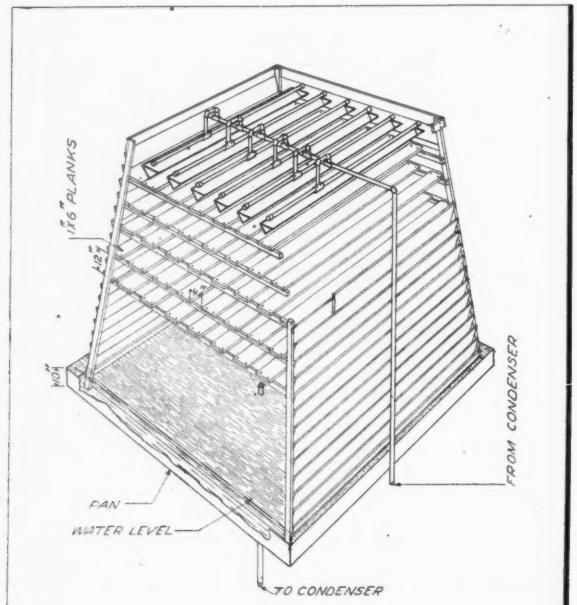
Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Cooling Tower; Types of Condenser

WE have a 4-ton ice plant, and wish to know what device can be used to the best advantage for cooling water. A submerged type of condenser is used and to my mind it does not condense fast enough, the water being 85 deg. F.

Would it be advisable to use the atmospheric type of condenser? What kind of water cooling is best?

J. F. M.



COOLING TOWER

A. We would recommend the atmospheric condenser, and for water at the temperature of 85 deg. F., you should have at least 120 ft. of 2-inch pipe for each ton of ice making capacity of your machine, and should use at least 4 gallons of water per minute. This quantity of water is based on leaving the condenser at a temperature of 95 deg. F. The submerged condenser will require at least 20 per cent more water.

It may be possible that your condenser needs purging; should it contain any air or decomposed gas this would cause your condenser temperature to run high, regardless of the amount of water that you might pass over the condenser. You can purge condenser by attaching a small pipe or hose to the highest point, where you will usually find a valve for this purpose. The end of hose should be placed in water and leave valve slightly open until all bubbles cease to appear or until a slight crackling sound is heard.

There are several cooling towers on the market; any one of them are efficient, but you can construct one as per sketch that answers very well for small plants. The average cooling tower will lower the temperature to about 10 deg. below the temperature of the surrounding atmosphere, with a loss of about 13 per cent of the water used.

W. H. Biesley.

Kerosene For Fuel

KINDLY advise me as to the cost of operating an oil engine with kerosene oil which is 7 cents per gallon here. G. A. P.

Any gasoline engine will run as well on kerosene. A different carburettor must be used, and gasoline must be used in starting. Fuel for a kerosene engine will cost about 7/10 as much as for gasoline, and will produce about the same power. You can buy more heat value in kerosene than in gasoline for the same money. The supply of kerosene is greater than gasoline. Three times as much kerosene comes from the crude oil as gasoline.

One and a half pints of gasoline will produce a horsepower hour by test at brake. J. C. Miller.

Removing Oil From Belting

I SHOULD like to ask a few questions in regard to the care of leather belts. What is the best way to remove the oil that has soaked in? Will constant scraping take it out without any other treatment? Will gasoline treatment be injurious to the leather? Can the oil be removed without taking the belt off of the machines? F. L. B.

A. He should first take steps, if it is possible, to prevent further oil from leaking on the belt, as it has probably worked out there from the bearings. Absorbent earth will take a good deal of the oil out of the surface fibres and will do the belt no harm in any event.

The washing mixture or gasoline alone will also take the oil out of the surface fibres, and, with the absorbent earth, will take a good deal of the surface oil out; but it tends to leave the leather rather dry and husky, and, of course, the oftener the washing mixture is used the more of the natural oil of the leather is dissolved out as well as the lubricating oil.

The washing mixture, however, can be advantageously used if some preservative material like Cling-Surface is applied immediately thereafter; but, unless this material is of greater density than the oil, nothing will be gained. W. D. Young.

Distance Between Pulley Centers

KINDLY give me a rule for determining required distance between pulley centers under the following conditions:

Driving pulley 37 in. in diameter, 30 in. face, 495 r.p.m. Driven pulley 108 in. in diameter, 30 in. face, 160 r.p.m., power to be transmitted 300. J. B. M.

A. The distance on centers at which pulleys can be set depends, as you know, on the arc of contact, which is permissible. You can run down to almost any arc so long as sufficient belt width is allowed, but in the case of your drive you have not very much excess allowance for carrying the amount of power required. The power that

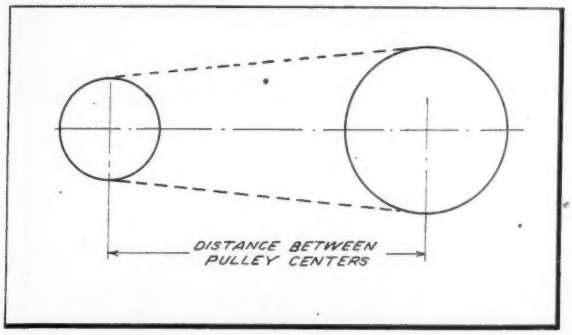


DIAGRAM SHOWING DISTANCE BETWEEN PULLEY CENTERS

can be carried varies as follows, taking the value at 180 deg. contact as 1: At 170 deg. it is 0.97, at 160 deg. 0.94, at 150 deg. 0.91, at 140 deg. 0.87.

The rule in regard to this is as follows: From 180 subtract the arc of contact; subtract the smaller diameter of pulley from the larger, multiply by 57 and divide by the difference in arcs already found, all dimensions being taken in inches. In your case I have assumed that 160 deg. is as low as we ought to go. 180 — 160 = 20. The difference in diameters is 71, which multiplied by 57 and divided by 20 gives 202½ inches, or 16 ft. 10½ in. as the distance on centers. A. L. R.

Engine Foundations and Smoke Stacks

WE are contemplating the installation of a new power plant and would like to have your opinion on some details. We think of installing 2 250-hp. water-tube boilers and one 225 hp. high-speed engine, steam pressure to be from 125 to 150 lb.

Ground that the plant is to be placed on has about 3 to 4 ft. of sand on top of the bed rock and I would like to know how long or how deep down the anchor bolts for engine foundations should be, that is, how much concrete should be above the bottom plate of anchor bolts to hold an engine of 225 hp. I would also like to ask if we would need any padding between bottom of foundation and rock below and if any what kind? The power house will be a building by itself. I don't think we would get much vibration from the engine, do you? Can you give any rule for figuring sizes of smokestacks? W. R.

A. In order that engines, whether steam or gas, may operate in a satisfactory manner as far as vibration is concerned, the foundation should extend down to solid ground, or if the nature of the soil is bad, piling should be used. There is no rule as to depth. The writer has erected a 1000 hp. tandem high-speed Corliss engine on a foundation which it was necessary to extend 23 ft. below the level of the ground in order to secure a solid base, and 28 ft. above it to bring the engine to the right height.

In this instance the foundation bolts extended 8 ft. below the bottom of the frame. If the solid rock is only about 4 ft. below your floor level, excavate until you strike rock and build the foundation on it without any padding whatever and there will not be any vibration.

In this case arrange to have the bottom of the cage washer boxes rest right on the solid rock for 4 ft. will be plenty. If you have any doubt about the material in the foundation itself, you might lay in some reinforcing strips, old pieces of pipe will do, over the top of the cage washer boxes, though this is not even necessary with good honest construction.

Boilers of the size you propose to install should have a good, solid foundation, and we advise that they also rest on the rock.

A smokestack is something that is very erratic in its behavior, and it is almost impossible to give any rule by which to determine chimney sizes that is not subject to change owing to local conditions. Other things being equal, location has much to do in determining the size of a chimney or stack. If there are high buildings or hills near the proposed site, this must be considered in determining the height of the chimney.

Fuel also has much to do with the size of the chimney, for if the fuel is to be wood or shavings, the draft will not need to be so intense as if it were anthracite slack, for the reason that the wood requires less air for proper combustion than the coal.

If the chimney is too large for present needs, it can be made to meet them by means of the dampers and drafts, but if it is too small, the only remedy is artificial draft, and that is expensive. It is usually considered that a boiler of 150 rated hp. should have a chimney not less than 90 ft. in height in order to burn the ordinary low grade coals.

Firms who make a business of designing and building chimneys and steel stacks have, from watching the operation and efficiency of their various designs, evolved a "Table of Sizes and Capacities" which is quoted in many engineers' reference works. Then let local conditions govern such increase in size as may be necessary.

In a general way, one sq. ft. of stack area will take care of about 6 sq. ft. of grate surface for a stack of proper height. G. H. Wallace.

Law of Floating Bodies

KINDLY explain the laws of floating bodies.
M. B.

A. The matter of floating of bodies in water is rather confused because people do not realize the difference between air floatation and liquid floatation. Floating is due simply to the difference in pressure on the under and upper side of the body and this is due simply to the different pressures at different levels in the liquid.

For instance, in a pan of water the pressure at the surface is atmospheric, while the pressure one ft. down is 0.434 lb. per sq. in. This pressure is exerted in all directions, and if a block of wood one foot deep is thrown into the water and held with the top of it level with the surface, the pressure upward on the bottom will be 0.434 lb. per sq. in. and on the top will be 0. There is, therefore, a force tending to push the wood upward which is equal to 0.434 multiplied by the area in square inches of the bottom of the wood.

If the wood is released and allowed to rise, it will be forced upward until the total pressure on the bottom is just equal to the weight of the block, but it must be remembered that as the block rises so that its bottom is at a less depth below the surface, the pressure per sq. in. decreases. For instance, when the bottom of the block is 6 in. (or ½ ft.) below the surface, the pressure per sq. in. upward on the bottom is 0.217 lb.

Take a piece of solid iron 1 ft. deep and put it into the water, and the same conditions will exist while the surface of the iron is held level with the surface of the water, but here the upward pressure on the bottom of the iron is not sufficient to lift the iron because a piece of iron 1 inch square and 1 ft. deep will contain 12 cubic inches, which weighs about ¼ of a pound per cubic inch and 12 cu. in. will weigh about 3 lb., whereas the pressure tending to lift is only 0.434 lb. The iron will, therefore, sink in the water. Suppose it sinks to a depth of 10 ft. The pressure on top of the iron is 9 times 0.434 lb. per sq. in., and on the bottom is 10 times 0.434 lb. to the sq. in., so that the force tending to lift the iron is still 0.434 lb. acting upward on each sq. in. of the bottom. The iron will, therefore, continue to sink until it rests on solid bottom.

If, now, we have an iron box which is filled with air, the case is different because the pressure upward will be the same on the bottom, but the weight of the box will be only the weight of the iron shell, the weight of the air contents being negligible as compared to that of the iron.

The only reason that a ship floats is because it is a hollow iron box, the inside being full of air. When you turn the box bottom side up and allow the air to escape, the conditions are then the same as for a solid block of iron. Of course, in the case of the ship, conditions are slightly modified, because the finishings and furniture are of wood, but the weight of this wood construction as compared with the weight of the metal hull, engines, boilers, partitions, etc., is of small consequence.

If the ship sinks in such a way that a large amount of air is trapped in the different compartments, it will not, perhaps, go to the bottom, but some part of it will float above the surface, or the condition may happen where air is contained in a considerable number of the compartments and as the ship sinks this air is compressed until the point is reached where there is a balance between the weight of the air and metal and the upward pressure on the lower surface of the ship. This is, however, unlikely, as the ship usually plunges end on, or else sinks slowly so that there is plenty of chance for the air to escape. When this happens the ship sinks to the bottom exactly the same as a solid piece of iron would do. A. L. R.

Gas Engine Questions

I WOULD like you to give me through Practical Engineer a sketch of a simple mixing valve for a 2-cycle type gas engine operating on natural gas.

I have a 2-cycle engine, marine style, that when running full speed vibrates badly. Would a counterbalancing weight overcome this trouble? If so, how would I find the correct weight to put on the crank?

How are silencers made, such as those on automobiles? F. J. K.

A. Replying to your inquiry to Practical Engineer for a sketch of a mixing valve I would say that all that is needed for natural gas is to use a lever valve on the air and gas supply before the 2 units. Before the air valve place a check valve so that gas will not come into the air when the engine is not drawing fuel.

Adjust the air valve so that the engine runs well and do not change it afterward.

To start the engine open the gas valve part way and when it is running leave the gas supply valve at the point which has been determined before. Fig. 1 will explain this piping.

In reply to your question as to balancing your engine, I would say that you can not overcome this vibration completely. You can help it by placing on the crank shaft opposite the crank a weight equal to the weight of the offset part of the crank plus one-half the weight of the connecting rod.

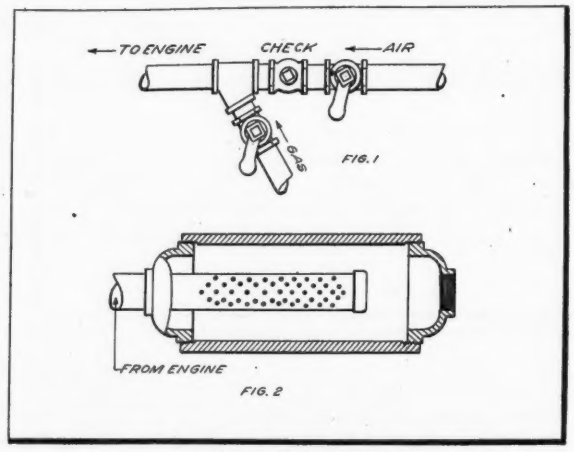


FIG. 1. MIXING VALVES
FIG. 2. GAS ENGINE MUFFLER

Mufflers (silencers) are made by conducting the exhaust pipe into a larger pipe through a reducer and drilling holes in the exhaust pipe to allow the exhaust to escape into the larger space through many small openings. The large pipe should have 3½ times the area of the small pipe, and the area of all the small holes should be equal to twice the area of the exhaust pipe, as shown in Fig. 2. J. C. Miller.

Enlarging An Ice Plant

I SHOULD like some information concerning our ice plant. We have a 7½ by 10 in. single acting 2 cylinder compressor running 95 r.p.m. The condenser capacity is 12½ tons, which makes 4 tons of ice per day besides 9400 cu. ft. of cooling capacity and we are using 200 lb. cans and would like to exchange and put in 300 lb. cans.

The 300 lb. cans will have to set on the bottom of tank and before making the change we should like to know if cans will work resting on bottom of tank and how much longer, if any, it will take to freeze the 300 lb. cans than it would the 200 lb. cans. H. L.

A. We would not recommend you to set 300 lb. cans on the bottom of tank, you would not get satisfactory results from this method. The time required to freeze a 200 lb. block of ice of the following dimensions 11 in. by 22 in. by 32 in. and with a temperature of the brine at 14 deg. is from 42 to 48 hr., and the time usually required for 300 lb. blocks 11 in. by 22 in. by 44 in. with the same temeprature will be from 54 to 60 hr.

If it was your intention to increase the output of your plant by increasing the size of your cans, and also to furnish the refrigeration required for the storage room that you mention in your letter, it is doubtful if your machine would be large enough. Though you could materially increase the capacity by increasing the speed on your machine say to about 125 r.p.m. W. H. Biesley.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Specific Gravity of Brine

IN answer to J. C. Hawkins' question in July 1 number, I should say that no doubt he dipped the brine from the top of his tank and the mystery of the differences in sp. gr. of different vessels filled, lies there.

If Mr. Hawkins would draw his brine for testing from a valve located near the middle of the brine tank, no doubt all readings would correspond at the same temperature. If drawn from very bottom of brine tank a yet higher sp. gr. would be found.

P. A. Guthormisen.

Boiler Questions

I UNDERTOOK to figure the unbalanced pressure on a check valve, which was 1¼ in. and used on feed water line to boiler. The diameter of opening in seat is 1 9/16 in., effective diameter of disk is 1⅞ in. I found areas from both diameters by squaring diameter and multiplying by .7854 and subtracted one from the other and divided by 100, which is boiler pressure and found I got 84+, which is the pounds pressure above the boiler pressure that the pump would accumulate before check will open. Of course I know it is not so, but cannot find my mistake, so will you please set me right on the subject?

2. Are through braces screwed into heads of boilers? How are they kept from leaking around threads?

3. What boilers have tube holes in rows diagonal to axis of shell or drum?

4. Why should lead gaskets not be used for handhole plates in boilers?

5. Why should blow-off pipes not be over 2½ in. diameter?

6. Why are safety valves over 5 in. in diameter not allowed in Massachusetts?

7. Why is a rivet in double shear not considered twice as strong as one in single shear?

8. Why are tube sheets always thicker than the shell?

9. Is it good practice to use diagonal stays directly over the fire for shell plates? If not, why?

10. What are the disadvantages of brass blow-off pipes? H. C.

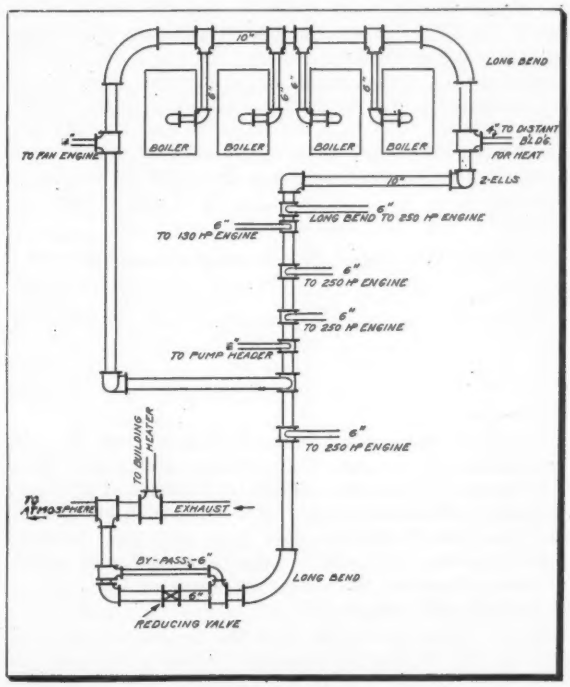
Will a Concrete Dam Affect Feed Water?

I WOULD like to have the opinions of other readers as to whether concrete will affect boiler feed water. In one case that came under my attention a large interurban railroad company built a concrete dam across the river to maintain a sufficient water supply for the condensers, also a concrete sewer about ½ mile long to carry the hot condensing water back up the river to be used over again in case of low water.

The boilers, of which I had charge, took water from the same stream about ¼ mile below the dam, and, for about a year following this concrete construction, our boilers scaled worse than before. The scale analyzed about 75 per cent calcium carbonate, 20 per cent calcium sulphate and 5 per cent other matter. There was very little difference in the composition of the scale, except that it was harder and there was a great deal more of it than before. During this year the boilers carried a larger load and used more water, so that I am not sure whether the extra amount of scale was due to this cause alone, or partly due to the leaching of the concrete, which was made of hydraulic cement, limestone and sand. J. C. Hawkins.

Location of Valves

I WOULD be pleased to have the opinions of different engineers as to where the valves should be placed in this steam system. The idea is to get the proper number of valves to give the best result, and yet keep the cost down to a reasonable figure. The steam pressure is 100 lb. One boiler will carry the minimum summer



PIPING LAYOUT

load; the winter load requires 2 and usually 3 boilers. The small engine carries the night load, and 2 of the large engines will carry the maximum day load; some live steam is used in the building heater in cold weather in addition to the exhaust; the boiler branches are horizontal. J. C. Hawkins.

Answers to Problems

IN the June 15 number J. R. asks what would be the most economical point to carry the water in a return tubular boiler and I should say the highest point that will not cause priming when the boiler is worked to its maximum capacity, whether it be 1 or 3 gages of water. With a greater volume of water it will not be so noticeable in changing the temperature of the entering feed water to the boiler pressure as with a smaller amount of water although there will be the same number of heat units used which is the reason that it is custom to carry a high water line.

In the same number C. A. M. asks if a safety valve on a pipe will work the same as on a drum and I will say from experience that it will not unless the spring is stiffer, as the working of the engine valves taking steam will cause the safety valve to chatter and hum unless the blow back is increased which I think from 1 to 2 lb. is enough for any valve to waste. Another thing is that valves on a cross pipe, I find, have to be reseated oftener than those on the drum caused by the wear on the spring. One valve we have that is used runs about 5 lb. light in a year although the blow-back stayed at 1 lb. all the time.

C. A. M. also asks about piping an injector and the proper way of installing it to a feed line and I think in most cases with injector the stalling pressure is not known and sometimes it is not more than 10 or 15 lb. more than the boiler pressure and with a few elbows and check valves in the line they never work well. To find the stalling pressure put a gage near the injector on the feed line and close a valve so as to shut the discharge off and note the pressure on the gage when the injector kicks and if the pressure is from 25 to 35 lb. above the boiler pressure you know that the trouble is elsewhere, but if only 5 or 10 lb. it is cheaper to put new tubes in an injector than waste time with them. Of course, it is to be considered that boiler pressure is got to the injector and the lift not more than 10 ft., when getting the stalling pressure as an increase in suction means a decrease in discharge pressure. D. T. Crowther.

Some Advanced Engineering Questions

THE following questions are taken from an examination given to the students in an engineering course at one of our prominent schools and are good to test out one's knowledge of the problems which are liable to arise in power plant installation and testing.

1. A water rheostat is made of 2-in. pipe, 2 pipes being placed 15 in. apart on centers and pipes being 30 in. long. If they are placed in a barrel of ordinary city water what current will flow with 2000 volts upon the line, what current can pass through without undue boiling. (In this connection read the article on water rheostats and the data sheet of the issue of November, 1911, page 759.)

2. A boiler uses coal, has the following composition; carbon 84 per cent, oxygen 4 per cent, hydrogen 6 per cent. 24 lb. of air are supplied per lb. of coal, the chimney temperature is 565 deg. F., the feed water temperature 100 deg. and the boiler pressure 100 lb. gage. In the furnace 90 per cent of carbon is burned to carbondioxide and 10 per cent to carbonmonoxide; 5 per cent of hydrogen escapes unburned. Steam made by the boiler is 99.05 per cent dry. Neglect the moisture of the air and radiation from the boiler surface. 18 lb. of coal are burned per sq. ft. of grate per hr.

Find the B.t.u. generated in the furnace per hr.

What is the temperature of the gases in the furnace?

What are the efficiencies of the furnace and of the boiler?

What grate surface will be required for 1000 boiler hp. in 8 boilers?

What will be the length and width of the furnaces?

What length and diameter of tubes and what heating surface is needed for each boiler?

3. What is the proper remedy for feed water containing magnesium carbonate and calcium carbonate?

What for water containing calcium sulphate and either calcium carbonate or magnesium carbonate?

What are the causes and methods of prevention of foaming? Of priming?

4. Design the cylinders for a 2000-hp. compound condensing engine to operate under the following conditions: The total expansions to be 25; r.p.m. 100; boiler pressure 250 lb. gage; vacuum 28 in.; diagram factor 0.9; stroke 4 ft.; ratio of cylinder volumes 1 to 5; receiver volume ½ that of the low pressure cylinder; steam 99½ per cent dry; clearance in high pressure cylinder 4 per cent; low pressure clearance 6 per cent; temperature of the incoming cooling water 70 deg., and of the discharged water 90 deg. F.; engine efficiency 94 per cent; generator efficiency 95 per cent; boiler efficiency 73 per cent.

The quantities required are the diameters of high and low pressure cylinders; the rate of steam consumption per hour per indicated horsepower; the steam consumption per hour per kilowatt; coal per indicated horsepower per hour, with coal having a heat value of 1400 lb.; water evaporated per lb. of coal; theoretical cards from the engine; for air pump at 100 r.p.m. with 12 in. stroke, diameter of the pump cylinder and of the steam cylinder.

Voltage Drop of Generator

IN answer to C. M.'s "Voltage Drop of Generator" would say that in the first place the absence of a rheostat suggests itself as being the cause of the trouble. But if as he says the voltage is lower one hour after running than at the start it would indicate trouble elsewhere. No regulator being in circuit the shunt field would have maximum strength at starting and as it warmed up its resistance would increase and magnetizing strength decrease.

Being a compound generator the shunt across the series field is either so heavy that it shunts all the current the series coils should carry and makes them inoperative or the series and shunt coils are opposing each other. In that case as the load increased and the series coils gained in strength they would oppose the magnetizing effect of the shunt coils thereby decreasing the strength of the field and consequently the voltage.

I would therefore try changing the connections of the series or shunt coils and also insert a rheostat in the shunt field for regulation as even with a flat compounding adjustment on the series coils a little regulation of the rheostat by hand is necessary to maintain constant voltage, due to the fact that the flux of the generator is not proportional to the exciting current, consequently at partial loads the voltage would be higher than at no load or full load. P. J.

Voltage Drop of Generator

ON page 541 May 15 issue of Practical Engineer, C. M. asks the cause of the 20 volt drop in his generator after it has been running for an hour or so. The reason is heat, which increases the resistance of his field windings allowing less current to flow through them thereby weakening the magnetism and consequently the voltage.

He will probably find that the generator has also dropped off some in speed due to the belt heating, and consequently slipping. His remedy would be to increase the speed of his generator sufficiently at the outset to give a higher voltage than he needs; keeping it down to his actual wants by regulating with the field rheostat and then cut the rheostat out step by step as the voltage shows signs of dropping in order to keep it up to 110. He says that the machine runs cool but that expression is somewhat elastic.

W. T. Menizer.

Voltage Drop in Generators

IN May 15 issue of Practical Engineer, page 541, is a problem submitted by C. M., that I wish to discuss. The trouble seems to be that in one hour's time the fields get thoroughly heated and the increased resistance cuts down the field current enough to account for this drop in voltage.

Would suggest that C. M. run his machine until the voltage gets down to 90 and then shut down and go over all connections to see if any are heated or loose. The expansion of hot coils may easily draw apart a joint that is all right when cold. Take off any tubular brass connectors and shove in a twist drill of proper size to scrape the brass clean and thus assure yourself that the connection is clean.

Some times the connectors are bored too large and small standard wires are not bound tightly even with screws set down to the head. If the machine has an accordion shunt strip at the series field terminals see if it is not bearing against the frame. These are generally located at lower part of machine and get full of dust. Charles M. Greene.

Answers to Problems

IN the June 15 issue of Practical Engineer, C. A. M. asks some questions I should like to answer. The chief objections to mounting a safety valve at a considerable height above the boiler are: That an accident may happen to the long pipe, or the valve may become inoperative and the attendant not discover it. The friction of the steam in the long pipe may reduce the effective area of the valve, and if water collects at any point in the pipe or is thrown into the pipe when the valve operates, there is great danger of wrecking the valve.

A better arrangement is to locate the valve next to the boiler and run a discharge pipe from the valve to the outside. Make sure that the discharge pipe has no water pockets and provide an ample drain at the valve so that no water can collect on the valve seat and act as a weight to prevent the valve from lifting. The discharge pipe, if very long, should be a size larger than the discharge opening of the valve.

There are no special connections necessary for feeding a battery of boilers with an injector different from the connections for feeding one boiler. The suction line of the injector should be as direct as possible with a lift of not over 20 ft., the lower the lift the better. Make sure that the suction line is perfectly air tight, as a small air leak will prevent the injector from working. Do not connect the suction to the suction of pumps, as the pulsation of water in a pump suction will prevent the operation of the injector. Be sure the suction is as large as the connection on the injector, and if very long it should be one size larger.

Make the steam connection to a pipe where the injector will get a steady flow of steam at the standard pressure. If this connection can be made direct to the boilers and independent of all other outlets, it is much better, as this insures a steady flow of steam without pulsations. The discharge or feed pipe, if very loud, should be a size larger than the discharge connection of the injector.

To operate the injector be sure that all of the feed valves at the boilers are wide open, then start the injector, and if of the positive action type, close the overflow very slowly to start the column of water in the long feed pipe gradually. If you try to start it quickly it raises the pressure in the feed pipe beyond the range of the injector, before the injector can get the water in motion, and then it kicks.

When handling the feed at the boilers, always run with the valves wide open if possible, and before throttling the water on the boilers receiving the most water always see that the valves are wide open on the boilers receiving the least water.

If the water is shut off from enough boilers to reduce the discharge openings so that the pressure in the feed line is raised above the range of the injector, the injector will kick. Wilmer R. Hersey.

Surface Condenser Installation

R. H. R. SHOULD surely locate his surface condenser and its combined air and circulating pump, in a pit below the engine room floor, if this is possible; rather than as shown in the sketch on page No. 687 of July 1 issue of Practical Engineer. One of the technical papers of recent date describes the practical wreck of a large Corliss engine, on account of water in the cylinder pumped back from a pocket in the exhaust line. The writer has just had called to his attention a disastrous accident to 3 engines exhausting into a common main to the condenser, due to the same cause. The engines, which were cross-compounds, were being turned over preparatory to taking their load. Suddenly, and without warning, all 3 of the engines caught water in their low-pressure cylinders, which were badly damaged.

In this case it was finally determined that the water could not have come from the condenser, but was simply water of condensation, which had gathered in the pocket in the horizontal exhaust pipe. This horizontal exhaust was supposed to have been protected by a drip tank and exhaust drain, and in addition by a vacuum trap. These devices are a makeshift at best. Unless it will prove extremely expensive, therefore, so locate the condenser, whether it be a jet or a surface condenser, that there will be a natural drain from the low-pressure cylinder to the condenser chamber. John W. Bruce.

EVERY MAN realizes that there are things about his own business that are pretty hard to figure out. But almost every man thinks he can see through the other fellow's business as he can through a plate-glass window. And men who have never been in any business but politics believe that they have vision like the X-rays.—Silent Partner.

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VALUE OF STUDY

Few modern plants are without electrical equipment of some kind, and the engineer of to-day must possess a practical knowledge of electrical engineering to make his services as valuable as they should be. In many instances the young engineer, who has just graduated from the grade of fireman, has had no opportunity to gain practical or theoretical knowledge of electricity.

Older engineers who have been operating purely mechanical plants, in many instances, have not realized the necessity of informing themselves on any other than mechanical lines. When opportunity arises to secure charge of a larger and perhaps more up-to-date plant, where electrical machinery is used, this lack of the proper knowledge to fit a man to make a desirable change, at once becomes apparent.

We all know from practical experience that it is hard, after working all day, to sit down in the evening and study and many have the belief that, if their early schooling was deficient, it is useless to try to gain a working theoretical knowledge.

This idea should be banished as many prominent engineers of today rose from the arduous task of swinging a coal scoop or wearing a tool belt, to their present positions simply through perseverance and regularity in applying themselves each day to study.

Even a half hour's daily study, if carried out systematically, will accomplish a great deal in the course of a year and the earnest student will be astonished at the knowledge gained and will be so much encouraged that he will work all the harder the next year, and with increasing efficiency.

Systematic study is what counts the most, and unless some course is laid out for the man who studies alone, he will naturally follow the path of least resistance and omit many things that he should have learned. Having this fact in mind Practical Engineer published in the July 15th issue the first of a series of articles, entitled "Practical Electrical Engineering," which will cover the field for the practical man and will be written in such a manner, with the introduction of practical problems, that it will be perfectly understandable to those who have not been fortunate enough to have the necessary foundation of an education to grasp more complex problems at the start.

This series of article will be supplemented by other subjects treated in a similar manner, each of which will lead up to a more advanced treatment of its particular subject. The editors wish to encourage study on part of Practical Engineer readers who have, by force of circumstances, been deprived of the knowledge they wish to possess and if any part of any article seems obscure will gladly endeavor to make it clear by correspondence.

For the readers with advanced education there is a host of good material yet to come. Suggestions for the particular class of articles which seem most beneficial to the readers will be gladly received. We want you to feel at liberty to make suggestions or criticisms at any time.

CONNECTICUT N. A. S. E. CONVENTION

A Creditable Assemblage at Bridgeport

EVERYBODY is doing it now, in the matter of conventions, and the Connecticut organization of the National Association of Stationary Engineers did their part in good shape at Bridgeport on June 28 and 29. The convention was the 17th Annual of the Connecticut organization and was held in Colonial Hall, Fairfield Avenue, in conjunction with a fine display of mill supply goods by the Supply-men's Association of Connecticut.

The convention opened at 11 o'clock Friday morning with a good attendance of delegates from all parts of the state. The delegates were welcomed by Mayor C. B. Wilson, who said a number of new things, and was responded to in kind by Edward Kearney of Boston, president of the National Association. A pleasant feature of the morning exercises was an appreciative and interesting address on "Stationary Engineers," by F. J. Mulcahy, vice-president and general manager of the Crane Valve Company of Bridgeport.

ENGINEERS AT THE CONNECTICUT CONVENTION

At the close of the morning session the supply men held their annual meeting and elected the following officers for the ensuing year: President, E. P. Upson, Hartford; vice-president, W. Birge, Bridgeport; secretary-treasurer, W. H. Larish, New Haven; executive committee, F. S. Buckley, New York; John Foote, New York; Charles Towner, Holyoke, Mass.; John Harrington, Springfield, Mass., and R. H. Stiles, Boston.

At 2:30 p. m. the delegates took a trolley trip by invitation to inspect the extensive works of the Crane Valve Co., where much was found to interest and instruct the visitors, especially in the power house with its fine equipment of turbines and electrical apparatus. In the evening there was a program of educational talks with vocal and instrumental music. Past National President Herbert E. Stone spoke on "The Relationship of the Engineer to Supply-men and the Benefit of Such Relationship to the Men who Purchase the Goods."

C. Cooley, superintendent of power, New York, New Haven & Hartford Railroad Company, gave an interesting and instructive talk on "Recent Installation of Power Plant Equipment."

H. J. Maynard, illuminating engineer of the General Electric Company, spoke on "Artificial Illumination." By a somewhat faulty arrangement this program was given in the exhibition hall, and as a majority of the visitors were evidently more interested in the exhibits than in the exercises the address failed to receive the attention their merits desired.

After the close of the evening session the engineers were invited to an informal smoker and luncheon at the grill room of the Hotel Stratfield, where they were the guests of the supply-men, and enjoyed a varied and excellent entertainment furnished by their hosts, in which the following well-known entertainers achieved their usual success: J. McKenna, of Jenkins Bros.; J. Devine, of The Peerless Rubber Co.; F. J. Corbett, of the Consolidated Valve Co.; Wm. Murray, of Jenkins Bros., and "Jack" Armour, of Power.

On Saturday, June 29, the delegates assembled for convention business at 10 o'clock. The proceedings were held in executive session, the president announcing that all present not members of the organization were required to leave the hall. It was subsequently given out that the convention for next year would be at Meriden, and would continue for 3 days instead of 2, as has been the custom. The following officers were elected to serve for the coming year: President, Thomas J. Phillips, of Hartford; vice-president, B. J. Reynolds, of New Haven; secretary-treasurer, C. M. Dowd, of Bridgeport; state deputy, F. M. Hastings,

of Meriden; trustees: W. B. Holt, of New Haven; Roger Granger, of Torrington, and Geo. P. Thomas, of New Haven; doorkeeper, Jacob Miller, of Ansonia.

After the convention adjourned the members and Supply-men boarded the Steamer Zepher and spent the afternoon enjoying the pleasant sights and cooling breezes of Long Island Sound.

The Exhibits

THE feature of the convention of greatest interest, both to engineers and visitors, was, as usual on such occasions, the exhibition of engine room and mill supplies. Over 60 booths, arranged along 2 aisles running the entire length of the hall, held an excellent display of up-to-date inventions and important adjuncts to efficiency in the modern power plant. The booths were in charge of men of the typical American business class, bright, alert and courteous.

THE H. W. JOHNS-MANVILLE Co. exhibited a full line of packings, especialy the "Sea Ring," which reduces friction to a minimum; and "Permonite sheet No. 60," adopte1 to meet any requirement or condition of service. B. C. McClure, manager packing and rubber department, H. T. Lyman and C. T. Pomer were in charge.

THE MASON REGULATOR Co. had a fine display of valves, regulators, reducing valves and damper regulators. The company was represented by F. A. Morrison and G. U. Poole.

THE AMERICAN STEAM GAUGE AND VALVE Co. had an attractive display of its standard and sterling goods, in charge of H. H. Nickerson and A. W. Hobs.

THE PERFECTION GRATE Co. of Springfield, Mass., exhibited its special grate with adaptable and movable sections. The merits of its product were well presented by W. L. Cronin.

THE M. T. DAVIDSON Co. of New York, represented by W. E. Brennan, and the Cochrane Co., by W. W. Montalvo, Jr., ocupied a booth in which there was a good display of pumps, heaters and condensers.

THE HANDY MFG. Co. of Bridgeport showed a line of die stocks which were simple as well as novel in construction and of high efficiency in operation. H. S. Ashman was in charge.

THE ROTO COMPANY of Hartford had on display, in operation, a number of its air or steam rotary boiler tube cleaners, which received much notice from visitors. Theodore Kalisher was the company's representative.

THE DURABLE PACKING Co. of New York exhibited a line of packings and gage glasses, the special merits of which were explained by J. A. Carson.

THE GENERAL ELECTRIC Co. presented a line of fans, fan motors, and other useful electrical devices; their new "orzonator" for purifying the air in rooms attracted much interested attention. The company was represented by W. D. Jenning, R. L. Brown and H. J. Maynard.

THE NIGHTINGALE & CHILDS Co. of Boston showed pipe coverings, cast-iron exhaust heads, separators and ventilators.

JOHN R. ROBINSON, New York, exhibited Boyer, and Warren, soot blower systems. J. H. Robinson and P. H. Rugg were the representatives.

TKE ASHTON VALVE Co. of Cambridge made a fine display of its standard and popular valves.

THE BRIDGEPORT TESTING LABORATORY and Chemists had an exhibit illustrating its methods of securing economy and efficiency in the purchase of oils coal, etc., used in factories. H. T. Leavenworth represented the company.

THE HARTFORD MILL SUPPLY Co. showed a line of valves and engine-room specialties. F. P. Upson was in charge.

THE PETERSON-ALLEN ENGINEERING Co. of New York showed a line of specialties, including the everlasting blow-off valve, which was much admired for simplicity of construction and evident effectiveness. C. H. Sleeper represented the company.

THE ARMSTRONG MFG. Co. of Hartford had on exhibition a line of the genuine Armstrong pipe threading and cutting tools. R. F. Ray represented the company, which he explains is the oldest in this line in the United States.

THE SMOOTH-ON MANUFACTURING Co. of Jersey City exhibited a line of cements, the merits of which were fully explained by their representative, C. E. Googins.

MCLEOD & HENRY Co. of Troy, N. Y., had on display a striking models of a boiler equipped with new "Dutch oven" structure, showing conditions obtained by use of the patent back combustion chamber arch. The exhibit as explained by the general and competent representative of the company, John H. Foote.

THE CRANDALL PACKING Co. exhibited a large line of its special grade packings. It was represented by O. W. Wagner.

THE CONNECTICUT METAL CLEANER Co. had an interesting display of its methods of removing scales from boilers, represented by B. N. Kerkins.

THE HOME RUBBER Co. had an excellent display of mechanical rubber goods. Richard Foley explained their merits to many interested visitors.

THE ALBANY LUBRICATING Co. had a varied and attractive display of greases and lubricants. W. D. Norton had charge of the exhibit.

THE A. W. HARRIS OIL Co. had a well designed display of oils in attractive glass packages. William Larish was the representative in charge.

THE SOUTHERN ENGINEER had a booth, which was in charge of L. L. Warren.

THE STANDARD REGULATOR Co. had a display of automatic devices for regulating temperature. John E. Miller was in charge.

THE CROCKER-WHEELER Co. of Ampere, N. J., had a fine display of electrical apparatus, in charge of W. F. Hurlburk.

THE T. HAWLEY Co. showed a line of mill supplies, making a special feature of its pressed steel shaft hanger. John H. Sepread managed the exhibit.

THE NATIONAL ENGINEER had a booth in the exhibition hall, and was managed by Chas. F. Ceilley.

POWER was represented by W. Buxmann, "Jack" Armour and N. C. Robbins.

THE IRON WORKS Co. had on exhibition the Crow chain grate mechanical stoker. J. Edgar Jones was the representative.

THE NEW ENGLAND ENGINEER was represented by Harry A. Robinson and L. T. Babcock.

W. R. WINN had an effective exhibit of oils and packings. E. S. Birge and W. Beach represented the company.

THE QUAKER CITY RUBBER Co. showed a general line of mechanical rubber goods. H. A. Howe was in charge, assisted by W. L. Stevenson.

THE KEYSTONE LUBRICANT Co. had an elaborate display of the standard and popular Keystone Grease. It was in charge of F. W. Gordon.

THE GARLOCK PACKING Co. also were in evidence with a line of its noted goods. They were represented by Frank Buckley.

THE PEERLESS RUBBER Co. displayed packings, hose and pump valves. C. F. Heitzman and H. L. Browne were there with the goods.

THE HAWLEY HARDWARE Co. showed paints and a varied line of factory supplies. C. J. Lindquist was the representative.

CHAS. A. CLAPPIN & Co. exhibited boiler tube cleaners, blowers and metal hose. The metal base was a particular object of attention and interest to visitors. A. W. Hughes was in charge of the exhibit.

THE W. J. HYLAND MFG. Co. displayed a large line of valves, faucets and the new drinking bubblers. J. J. Kirby managed the exhibits.

THE NATIONAL FLUE CLEANER Co. had on exhibition an effective model of its practical device for cleaning boiler flues. The representatives were Otto Dowatz and H. R. Strauss.

THE MIESICK Co. of New Haven, dealers in mill supplies, showed a good line of pipe tools. C. H. Albee and W. T. Doolittle were the representatives.

ESTATE OF EDW. LADEW had a large display of leather belting, a striking feature being a tank of water through which revolving pulleys continuously passed a number of belts in evidence of the power of the belting to withstand the effects of moisture. H. P. French was in charge.

THE LUNKENHEIMER Co., represented by their Connecticut manager, L. Daniels, showed a large and attractive line of engineers' specialties which received much attention from the delegates.

THE OTIS ELEVATOR Co. showed a line of oils, grease and lubricating apparatus especially adapted to elevator operation. George D. Jamison had charge of the exhibit.

GREEN, TWEED & Co. of New York had an interesting and well arranged display of lubricators, showing 18 different sizes and styles. E. H. Kelley was in charge.

THE SCHAEFFER & BUDENBERG Co. of New York had a fine display of gages, recording instruments, indicators, etc., which was in charge of the secretary of the company, C. E. Georgie.

THE JENKENS BROS. presented its accustomed fine display of valves, mechanical rubber goods and supplies.

THE CRANE VALVE Co. of Bridgeport made a particularly large and effective display of valves, including the special Cranetilt valve. The exhibit demonstrated the company's ability to produce valves designed to meet all requirements of the plant. H. A. Morse, the local manager, was in charge.

BAY STATE ENGINEERS IN CONVENTION

N. A. S. E. Convention at Northampton, July 11-13

THE Massachusetts State Association of the N. A. S. E. held its annual convention, for this year, at Northampton, on July 11, 12 and 13, and both delegates and visitors were unanimous in pronouncing the event a complete success. Two factors which contributed largely to the marked success of the convention were competency of plan and management on the part of those having the arrangements in charge, and cordial interest and cooperation by the Northampton Board of Trade and other local organizations.

At noon on Thursday, the 11th, there was a grand opening of the exhibition of power plant machinery and supplies in the City Hall. In addition to the attractions of the exhibition, visitors were entertained during the day by a program of excellent music furnished by an orchestra of engineers. In the evening there was an informal gathering of the delegates and supplymen at Bahar's summer garden, at which brief and pleasant speeches were made by prominent members of the Stationary and Commercial Engineers' Associations, and a general good time enjoyed.

The formal exercises of the convention opened at noon on Friday with an address by Mayor Feiker, in which he extended an official welcome to the visiting engineers, and indicated some of the advantages possessed by Northampton, of which its citizens were justly proud. President E. H. Kearney of the National Association responded, and voiced in appropriate terms the appreciation by the visitors of the hospitality and good will expressed by His Honor, the Mayor. Addresses were also made by Frank E. Davis, President of the Northampton Board of Trade; Claude D. Allen, president of the New England Association of Commercial Engineers; Henry P. Hogan, past president of the National Association; T. N. Kelsey, past president of the National Association, and H. E. Stone, past president of the National Association.

At 2:30 the regular business session of the stationary engineers took place, at which matters pertaining to the good of the Association were considered and acted on by a full attendance of delegates. Measures were adopted providing for the extension of the advantages of membership in the Association to all stationary engineers in New England. The following officers were elected for the ensuing year: President, John T. Maloney, of Fall River; vice president, A. M. Day of Northampton; secretary, Ole D. Peterson, of Boston; treasurer, Walter Damon, of Springfield; state deputy, Thomas A. Ray, of Boston.

The Commercial Engineers held their meeting at the same hour in City Hall, and elected officers as follows: President, Albert C. Ashton, of Boston; vice president, Frank A. Morrison, of Boston; secretary, T. C. De Grouchy, of Boston; treasurer, Herbert E. Stone; directors, Claude D. Allen, William K. Campbell, John B. Harrington, W. C. Barnes, John D. Stiles, John L. Hamilton, William Coppins, T. P. Burke, W. D. Hosley, B. L. Ames, G. A. Salmon and W. H. Walker.

Throughout the day and evening there was a large attendance of visitors at the exhibition of power-plant apparatus, and in the evening the delegates were entertained with a smoker and songfeast at Cook's Theatre. A moving picture show, in which films of special interest were employed, was an appreciated feature of the entertainment. A pleasant incident of the evening's entertainment was the presentation to retiring president, James H. Sumner, of a handsome silver service. Jack Armour made the presentation on behalf of the engineers, and was himself made the recipient of a valuable gold ring in the presentation of which President Davis, of the Board of Trade, played the star part. Both presentations were conducted in a particularly informal and jolly manner and were uproariously applauded.

A feature of the day's proceedings deserving special mention was an automobile trip given the delegates at 5 p. m., under the auspices of the Board of Trade.

The Convention proper and exhibition closed at noon Saturday, and the balance of the day was devoted to the enjoyment of a ball game, clam bake and trolley trip by special cars to Mount Tom and Mountain Park. Previous to starting for the Driving Park, where the ball game and clam bake took place, President Davis, of the Board of Trade, was presented with a large and valuable traveling bag with annex of an elegant ivory toilet set as a mark of appreciation by the visitors of his unremitting efforts in aiding entertain and making the convention a success.

ENGINEERS AND FRIENDS AT NORTHAMPTON

Shortly after the presentation to Mr. Davis, the engineers, both stationary and commercial, formed in line and headed by the Northampton Brass Band, marched to the Driving Park, which was the scene of the afternoon's festivities.

Marked attention was shown the members of the convention by local organizations and citizens of Northampton. A committee consisting of Messrs. O. M. Smith, Frank Haxley, M. J. Fitzgerald, Morris Crooks, W. H. Gore, J. Maloney and H. Bingley was appointed by the Mayor to co-operate with the local committee of stationary engineers towards making the convention a success.

The Northampton Country Club extended to the visitors the freedom of its grounds, golf links, tennis courts and club-house. The Northampton Lodge of Elks gave the use of Cook's Theatre without cost for the Friday night entertainment. The Northampton City Club extended the freedom of its club rooms, and the Northampton Electric Light Company donated all the electricity

used at the exhibition and at Cook's Theatre. The Local Convention Committee of the National Association of Stationary Engineers, to whose preliminary work much of the convention's success was due, was composed of the following members: A. M. Day, chairman; C. H. Hill, secretary; C. S. Clark, F. C. Howard, R. P. Benedict, J. J. Brennan, D. Morey and T. F. Butterworth.

Through the good offices of Mr. Williard, one of the engineers at Smith College, the Art Building and other places of interest in the institution were opened on Saturday for inspection by the visiting engineers.

The next convention of the Association will be held at Lawrence, Mass.

The Exhibition

THE exhibition feature of the convention was one of the most attractive and best conducted that has marked the history of N. A. S. E. assemblages in New England. It was given in the auditorium of the City Hall, which was completely filled with booths, uniform in size, and pleasingly decorated with bunting in shades of blue, white and light green.

The following concerns were exhibitors:

THE WELDING CO., Springfield, Boston, Hartford and Holyoke, had a presentation of their wonderful process of welding and manipulating metals. The repairing of boilers rapidly and economically was made a special feature of the exhibit. Henry Crane, the president of the company, was in charge.

THE ROTO COMPANY, of Hartford, had a well arranged display of its practical method of cleaning boiler tubes. A number of air or steam driven motors were shown in actual operation. Theodore Kalisher was the representative.

THE LAGONDA MFG. CO. showed a good line of boiler tube cleaners, automatic boiler stop valves, and malleable strainers. Wm. J. Patterson, the genial representative, dispensed a number of interesting and valuable souvenirs to the visitors.

THE PATTERSON LUBRICATING CO. displayed sheet-packing oils and grease. Art calendars and mirrors were given as souvenirs.

THE SOUTHERN ENGINEER had an exhibit in charge of Lewis Warren.

THE UNIVERSAL SUPPLY CO., of Springfield, Mass., exhibited the Semon cleaner. N. J. Hibbard was representative

THE GARDNER GRATE CO. had a display of the Gardner grates and constant-valves. Frank Gardner was in charge.

THE CURRY BROS. OIL CO., Boston, exhibited its specialties in oils and greases and cleansers. M. L. Curry was in charge.

QUAKER CITY RUBBER CO. had a general line of mechanical rubber goods. A special feature was a diagram illustrating the power-saving effect of P. P. P. Ebonite packing in actual service. The exhibit was interestingly explained by H. A. Howe, the representative of the company.

THE H. W. JOHNS-MANVILLE CO. had their usual elaborate exposition of specialties used in the power plant. A feature was boiler preservative for preventing scale, also the S E A ring packing and J-M high temperature cement as a substitute for fire clay. The exhibit was in charge of Wm. Coppins, assisted by E. Hofgarde.

THE HART PACKING CO. exhibited various grades of packing. Represented by H. Hart.

JENKINS BROS. showed its valves and packing. The line was managed by R. H. Stiles.

THE SCHAEFFER & BUDENBERG CO. of Chicago, Brooklyn and Pittsburgh, made an interesting display of Columbia recording gages, indicators, recording thermometers and steam calorimeters. C. E. George was the company's representative.

THE ENTERPRISE RUBBER CO. had on exhibit a full line of fire hose and fire apparatus. Gordon Hall, J. E. Stevens and C. F. Heitzmann were the representatives.

HOLYOKE VALVE & HYDRANT CO. showed a full line of steam and engineers' supplies, also a line of Kewanee specialties. G. H. Stibbs and R. M. Hall were the representatives.

THE STRONG MACHINERY & SUPPLY CO. exhibited hydraulic packings and a line of engineers' specialties. George D. Jewitt and Louis E. Strong demonstrated the merits of the goods.

THE ROBB ENGINEERING CO., LTD., of South Framingham, made a special exhibit of its Macdonald shaking grates. The model shown was very interesting to power-plant people, in the qualities of efficiency, safety and economy demonstrated. Wm. H. Walker, sales-manager of the company, was in charge.

THE LUNKENHEIMER CO., of Cincinnati, showed brass and iron valves, globe and gate pattern, lubricators, whistles and oil pumps. The booth was managed by W. W. Beal and Charles E. Allen.

THE EAGLE OIL & SUPPLY CO., of Boston, displayed Perolin German boiler compound, Skookum packing and Vander packing. The exhibit was in charge of J. L. Hamilton.

THE AMERICAN STEAM PACKING CO., of Boston, displayed a full line of packings and supplies. R. H. Anderberg dispensed information and souvenirs.

THE EVANS MILL SUPPLY CO., of Boston, had an attractive exhibit demonstrating its special steam trap for maintaining steady steam pressure. The demonstrators were S. S. and W. P. Evans.

THE MONARCH VALVE & MFG. CO., of Boston. had a fine line of high grade valves. W. D. Hasley was the courteous representative.

THE MANNING MAXWELL & MOORE MFG. CORPORATION had an attractive exhibit of gages, safety valves and Hancock valves. Nelson J. Allaben explained the merits of the specialties.

THE AMERICAN STEAM GAUGE MFG. CO. was to the front with a fine display of its standard and popular products, including gauges, valves and indicators. W. H. Nickerson represented the company.

THE DURABLA MFG. CO., of New York, exhibited Durabla metalic glasses, sheet packing and valve disks. J. A. Carson was representative.

DEARBORN DRUG & CHEMICAL WKS., of Chicago, gave out literature and useful souvenirs. Its booth was in charge of P. H. Hogan, the New England manager.

THE PERFECTION GRATE CO., of Springfield, showed its special make of grates for boiler furnaces. W. L. Cronin and L. J. Hibbard were the demonstrators.

WALTER G. RUGGLES CO., at its booth, gave out literature illustrating and explaining its power-plant specialties. W. G. Ruggles was in charge.

THE V. D. ANDERSON CO., Boston, exhibited a fine line of traps and seamless copper floats. L. A. Couch and F. M. Couch were the representatives.

THE McLEOD & HENRY CO. had an interesting exhibit of their Steel Mixture, showing model of steam boiler mounted on Dutch oven furnace formation. Its popular representative, John H. Foote, explained the merits of the goods.

THE W. J. HYLAND MFG. CO., of Springfield, had a very attractive exhibit of valves, faucets and drinking fountains, which received much attention. J. J. Kirby was representative.

THE MASON REGULATOR CO., of Boston, had its usual striking display of reducing valves, regulators and pump speed governors. F. A. Morrison and G. W. Boole were in charge.

THE GEO. W. KNOWLTON RUBBER CO., of Boston, made a good display of mechanical rubber goods for use with steam, water, ammonia and air.

THE KEYSTONE LUBRICATING CO. had an effective display of its celebrated products. The exhibit included a full line of greases, with special devices for securing good results with economy, in their application. Mr. Carpenter and Mr. Nahan were in attendance.

THE ALBANY GREASE CO. exhibited oils and greases with a large variety of apparatus for using them. V. Peavey and W. D. Naughton had charge of the booth.

C. A. CLAFLIN CO., with Mr. Claflin in charge of the exhibit, showed the good points of its special tube cleaners and hose fittings.

THE PHILADELPHIA GREASE MFG. CO. exhibited a special line of lubricating grease, in charge of T. Addison Collins.

THE TEXAS CO., of Boston, had on display a line of oils and greases put up in attractive sample packages. H. E. Shaw was in charge of the exhibit.

A. W. CHESTERTON CO., of Boston, had a good display of its German gage glass and boiler tube cleaners.

THE ASHTON VALVE CO., of Boston, had a fine display of safety valves, pressure and water relief valves, pressure and vacuum gages, gage testing and proving outfits, recording gages and blow-off valves. The company was represented by Columbus Gill, William Hampson and Harry H. Ashton.

WILLIAM R. WINN, of Springfield, showed oils, greases and packings. The House is the New England agent for N. B. O. packings. J. B. Harrington and F. B. Driscall were the representatives.

GREENE TWEED & CO., New York, displayed a line of the celebrated Palmetto packings, which were evidently popular with visitors. L. J. Vandervall had charge of the exhibit.

THE CHICAGO TOOL CO. made a striking and interesting exhibit of its extensive line of pneumatic tools and electric drills. F. L. Eggleston, Jr., represented the company.

THE BURKE ENGINEERING CO., of Providence, occupied a booth and were represented by Thomas P. Burke.

THE GARLOCK PACKING CO. made a fine and varied display of its standard and popular products. The booth, which was presided over by Claude D. Allen, secured a large share of attention and commendation from visitors and delegates.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

THE ELYRIA OIL ENGINE

2 Cycles, of This "Semi-Diesel" Type, with Low Maximum Pressure and Unjacketed Head, and Air Compressor Pump Self-Contained

ALL power users are growing to appreciate the necessity for fuel economy, due to the natural advance in prices of fuels, which is especially noticeable with the lighter refined oils, because of their increased consumption in motor vehicles. This has stimulated interest, especially among builders of internal combustion engines, in the Diesel type engine, and makes a description of the Elyria Gas Power Co.'s latest product, the Elyria Oil Engine, most timely. It should be remembered that all oils have about the same heat value per pound, hence weight of fuel, not volume, is the proper basis of comparison.

To meet our American market it has been generally believed that the straight Diesel type engine, because of weight, necessary mechanical refinements and auxiliaries, could not, in spite of its economy, be profitably developed and marketed except in sizes well upwards of 100 hp. per unit.

Some three years ago the Elyria Gas Power Co. undertook the supposed impossible feat of developing a line of tandem gas engines in sizes down to 20 hp. which would embody big engine practice. The success which met this effort quite naturally led the company to turn its attention to the production of an oil engine in medium sizes with big engine economy—a practical, salable, Diezel-type engine built down to 25 hp. The result of this effort is the engine here described.

The first departure from standard Diesel practice has been the adoption of the 2-cycle type, in order, first, to produce an engine of greater capacity for the same amount of material employed and, consequently, a lower priced machine per horsepower; second, to simplify the construction from the standpoint of the user by the elimination of valves and valve gear from the working cylinder.

The next step was in the line of lowering maximum pressures and the introduction of an unjacketed cylinder head and false piston end to make this practical, by the adoption of which features it is possible to burn the heaviest fuels with a maximum pressure not to exceed 400 lb. and without introducing missed igition

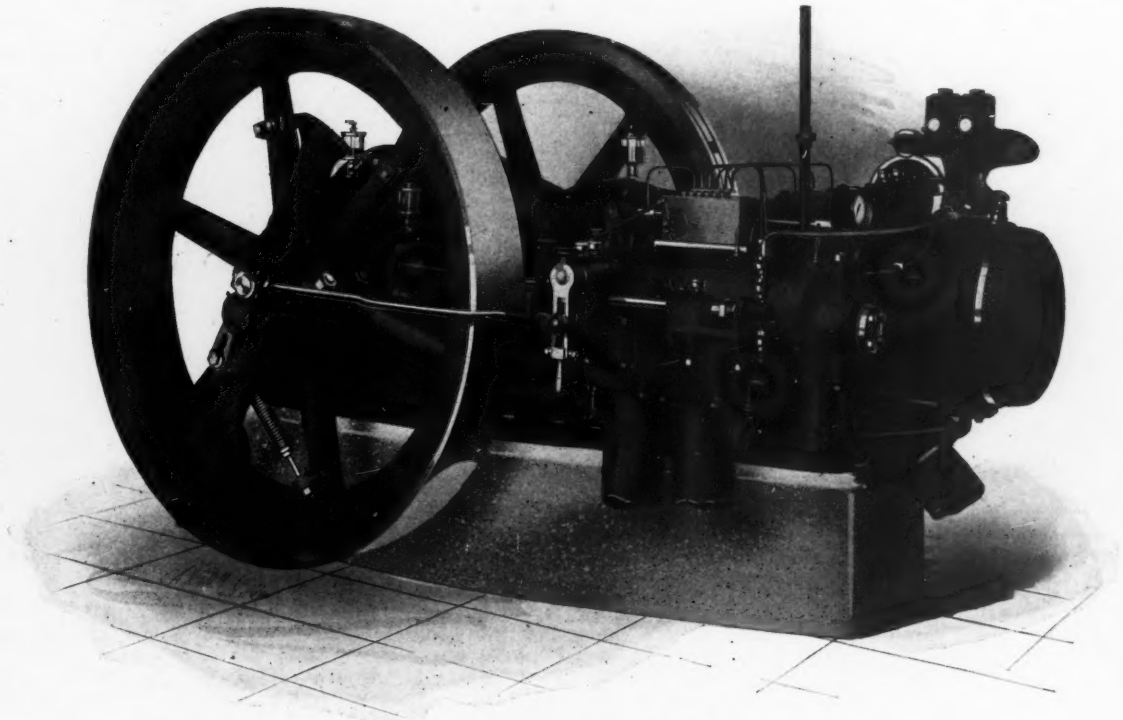


FIG. 1. WORKING SIDE OF THE ELYRIA OIL ENGINE

at light loads. Practically all oils can be used if properly atomized, and the Elyria system has been able to handle all oils so far tried.

These changes from the usual Diesel 4-cycle practice have been accomplished with practically no loss of thermal efficiency and with reduction of operating difficulties. The slight loss in thermal efficiency, due to lower compression, is compensated by having less jacketed surface exposed, and from a given cylinder volume, the 2 cycle arrangement develops about 75 per cent more power.

Some sacrifice would but naturally be expected in the modification of any well known and established type, and this is present in the Elyria engine in the fact that the fuel consumption per brake horsepower will approximate 10 per cent more than a standard 4-cycle Diesel of the same size. This loss is not due to the loss of thermal efficiency, but rather to loss of mechanical efficiency because of the extra work in handling the scavenging air.

Those familiar with the theory of the Diesel engine appreciate that its high efficiency is due not so much to high compression as to the superior breaking up or atomizing of the fuel and the advantageous conditions under which combustion takes place. To this end the Elyria engine employs the best that has been developed in the straight Diesel and goes even farther in the matter of automatic control, varying the injection air to correspond with the amount of fuel injected at various loads.

In developing the 2-cycle feature the first marked advantage over ordinary 2-cycle gas engine practice is the adoption of the differential piston in place of the usual crank case compression. The volumetric efficiency of the ordinary crank case seldom exceeds 70 per cent and is usually about 60 per cent, while the differential piston type of scavenging pump, owing to its small clearance, has a volumetric efficiency well over 90 per cent.

With this has been combined a liberal sized piston-valve control which eliminates a large part of the suction loss usually present in ordinary crank case compression.

The displacement of the scavenging piston is approximately 1.9 times that of the working piston and furnishes not only the necessary air for combustion but for thoroughly scavenging and cooling the working cylinder at each stroke.

The working and the differential piston are separate castings fastened together with 4 studs, the piston pin carried in the forward or differential piston, producing the effect of a crosshead, so that all side thrust is taken from the working piston.

To take out the working piston remove cylinder head, which is free from piping, and 4 nuts used to fasten together the 2 piston castings. The piston pin is easy of access.

The construction employed in the piston pin has proven excellent practice in the Elyria Co.'s tandem engine.

Because of clean burning of fuel, conditions in the cylinder correspond more closely to ordinary gas or gasoline engine practice than to oil engines of other Diesel type. In consequence, lubrication is easily effected by a minimum quantity of oil which is introduced by force feed pump at 3 points around the cylinder wall.

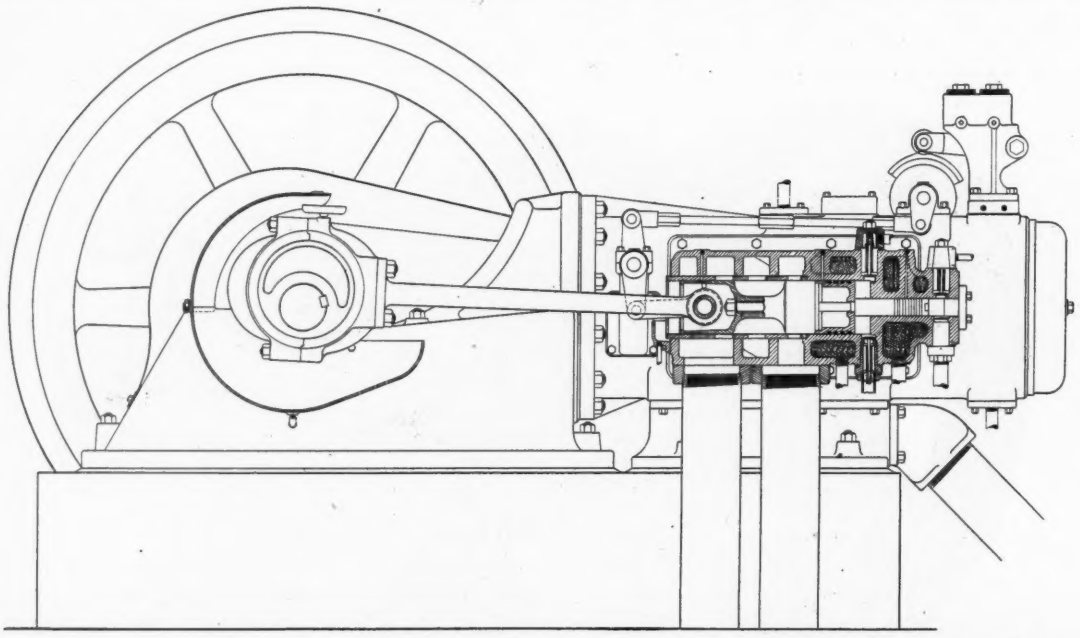


FIG. 2. COMPRESSOR SIDE OF ENGINE, SHOWING 2-STAGE ECCENTRIC-DRIVEN AIR PUMP WITH CROSSHEAD. PUMP ACTS AS A PISTON VALVE TO CONTROL LOW-PRESSURE AIR FOR SCAVENGING

Figure 3 shows that the piston head is a separate piece which increases its temperature and incidentally allows a symmetrical shape of the piston casting. It will also be noticed that 6 rings are used and that these are accessible for inspection by removing the cap over the inlet port at the top of the cylinder.

The bed is of heavy box type construction. Main bearings are interchangeable babbitted bushings, in length about 2½ times the shaft diameter, which is ½ the cylinder bore. The crank pin is 20 per cent larger than the shaft with marine-type, cast-steel box, babbit lined.

The connecting rod is a heavy steel forging of rectangular section and in length 5½ times the crank throw.

To provide air for injection 3 stages of compres-

sion are employed; the first stage accomplished by the scavenging cylinder and the second and third by a separate pump, eccentric-driven from the main shaft, as shown in cut Fig. 2.

Air from the large cylinder of this pump is piped to a tank which also serves as a starting air tank. The suction of this stage from the scavenging cylinder is taken care of by an automatic control which is set to keep this tank at any pressure desired, regardless of the amount of air used for fuel injection. In no case will this exceed 200 lb., which is no higher than pressure commonly employed for starting standard gas engines.

Air from the tank is piped to the suction side of the small high pressure piston and in this line is a valve controlled by the governor, which determines the amount of air admitted and, consequently, pressure delivered at nozzle to correspond with the load.

This pressure will vary from 500 lb. at light loads with easily atomized fuel, to as high as 1000 lb. per square inch with overloads and the heaviest fuels.

or gasoline engine and compressor are furnished with each installation.

The fuel pump it driven by an ordinary type Rites governor in the flywheel which varies the stroke of the pump plunger, thus proportioning the amount of fuel to the load. This secures a speed regulation within 2 per cent for 50 per cent load change, and within 4 per cent from full load to no load. The driving mechanism provides for disconnecting governor and operating pump by hand to pump up oil for starting. This method of disconnecting the pump is also employed in shutting down, as the oil supply is thereby immediately cut off. Provision is also made for giving extra stroke to the pump plunger to insure easy starting.

The mechanism for operating the fuel valve, while a little out of the ordinary, accomplishes the desired result in a simple and convenient way. The operation of the cam which lifts the fuel valve can be readily understood from Fig. 2, the fuel being admitted at the high compression point and through 10 per cent of the forward piston travel.

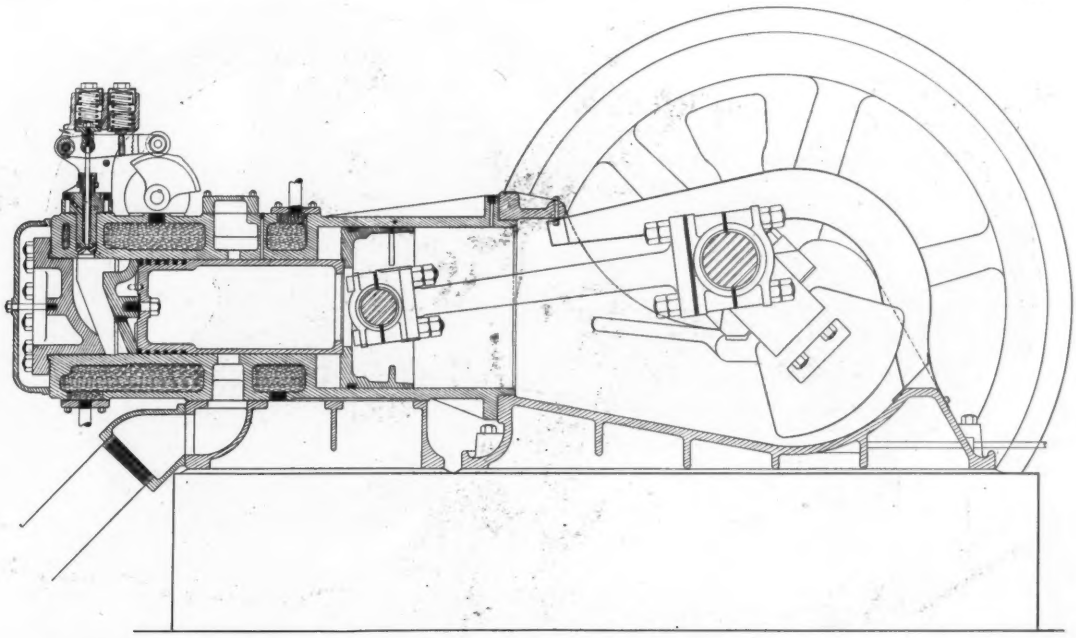


FIG. 3. SECTION THROUGH PISTON AND CYLINDER SHOWING DOUBLE PISTON, INLET AND EXHAUST PORTS, FUEL VALVE AND VALVE GEAR

This high pressure air travels through a short pipe direct from the high pressure compressor to the fuel valve casing, and the line is supplied with gage and pop safety valve.

For this method of air control are claimed many advantages over standard Diesel practice, among which are that the first stage compression is delivered by the scavenging cylinder without any extra mechanism; that there is only a short length of piping and no tanks for storing high pressure air; and that for all load conditions the air pressure and volumes are automatically controlled.

While the compression may be as high as 400 lb., 100 lb. tank pressure applied through automatic starting valve will readily turn the engine over and furnish sufficient air to the compressor for fuel injection.

To provide against the contingency of loss of pressure in this tank while the plant is idle, a small gas

In usual Diesel practice the matter of fuel valve timing is rather a delicate operation, while with the method employed in this engine all that is necessary is the adjustment of driving rod (fitted with right and left threads) until the cam is brought to a position which is shown by reference marks.

The sleeve around this fuel valve, which helps to break up and mix the fuel and air, is made from a single piece of steel. All openings are of ample size so there is no danger of clogging with the heaviest fuels.

As the lift of the fuel valve is only 1/16 in. it will be readily understood that the amount of work imposed on the valve-operating mechanism is very slight.

In starting the engine, cold gasoline is sprayed into the cylinder through the fuel valve, as are the heavier fuels in ordinary operation. To insure combustion, batteries, vibrator coil and plug are provided.

No commutator is used; consequently, a continuous shower of sparks is thrown into the cylinder, which serve to augment the heat of compression and insure burning.

Within 60 sec. from the first fuel introduction the switch can be thrown out, the heavy oil immediately turned on and full load thrown on the machine.

As has already been explained, the working piston is lubricated from a force feed pump, which also furnishes the small amount of oil required by the compressor cylinder.

All important bearings, such as main bearings, crank pin bearing, eccentric, scavenging piston, or crosshead, and crosshead pin, are taken care of by a continuous type of oiling system. Oil from an overhead tank is fed to the bearings from which it runs to a sump tank and is then pumped to the overhead tank, and after running through an efficient filter, is again ready to be returned to the bearings.

The amount of high grade cylinder oil fed by the force feed pump does not exceed one pint per 100 hp.-hr., while the loss of the cheaper engine oil in the return system is extremely small. This arrangement takes care of everything except a few minor bearings which are provided with grease cups.

The continuous oiling system is of such capacity as to require no attention for weeks at a time, while the cylinder pump need be filled only twice in 24 hr.

The cooling system is extremely simple, having but one point of inlet and one outlet. All water is admitted around the compressor cylinder from which it goes to the working cylinder and is there discharged. The cooling water required for this type of engine is less than for an engine of explosion type. With water entering at 60 deg. F. only 3 gal. per horsepower-hour are needed.

Simplicity of mechanism gives the engine smooth and quiet operation.

The Elyria Oil Engine is being marketed under a fuel guarantee of 0.65 lb. per brake horsepower-hour at rated load and not to exceed 0.75 lb. at half load. Excellent speed regulation is assured by use of the heavy type, quick acting Rites governor.

Engines of the type described in single and twin construction, from 25 to 125 hp., are now being offered for stationary work at speeds of 240 to 260 r.p.m.; a line of vertical multicylinder engines for marine and stationary direct-connected work is under development.

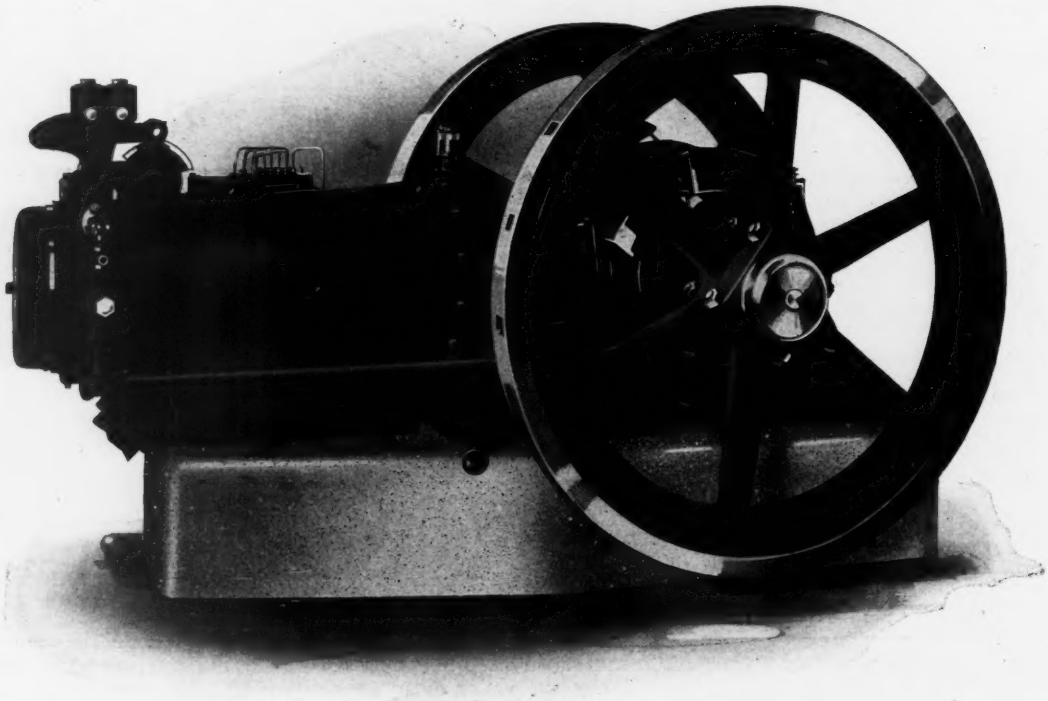


FIG. 4. DRIVING SIDE OF ELYRIA OIL ENGINE

PENBERTHY AUTOMATIC CELLAR DRAINER

PENBERTHY water pressure ejector of high capacity, automatically operated by a float-controlled, quick-opening-and-closing valve C, Fig. 1, forms the essential feature of the Penberthy automatic cellar drainer. This valve is never partially opened, it allows the ejector to give its greatest efficiency by working to full capacity. The float arms are slotted at A, where they connect to the valve lever C, this prevents the ejector from operating until the water has raised the float up to the highest point, and, as the water is ejected, they travel down the length of these slots before the weight of the float affects the valve. This allows the machine to work for longer periods and not so often, thus preventing considerable wear and the leakage and dribbling of water.

To enable the installation of this drainer in small holes, or sumps, it is made as compact as possible. The float, instead of being round, is flat on the top; it has more buoyancy and occupies less space than a round float of the same diameter. Further economy of space is secured by building the float around the suction pipe B. This patented feature has the added advantage of being rigid and overcomes the trouble of

the loose float. The balance of the drainer is built directly above the float; this not only keeps the whole machine in as small a space as possible, but also keeps all working parts with the exception of the strainer and float, above the water, thus preventing corrosion or the exterior parts becoming clogged up by deposit of slime, dirt, or sediment.

The interior parts are prevented from coming in contact with any foreign particles by the special strainer, H, which is so constructed that instead of the water being drawn directly upward it is taken in at

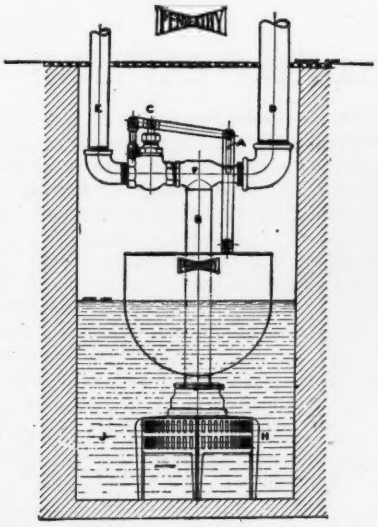


FIG. 1. SECTIONAL VIEW OF PENBERTHY AUTOMATIC CELLAR DRAINER

the sides allowing all sediment to collect under the strainer without being disturbed by the force of the suction. A foot valve inside the strainer is also provided which closes the instant the drainer ceases operating, holding all water in the pipes, all primed for starting instantly, at the next filling of the sump.

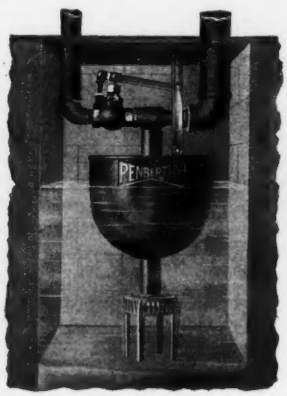


FIG. 2. PENBERTHY AUTOMATIC CELLAR DRAINER

The Penberthy automatic cellar drainer is particularly adapted for use in sumps, cellars, tanks, settling basins, or wherever it is desired to keep water or other liquids from going above a certain level. It is made of bronze metal, except the float, which is copper, and can be regulated for any water pressure. This apparatus is the product of the Penberthy Injector Co.

NARROW GAGE RAILWAYS FOR COAL AND ASH HANDLING

NARROW gage railway systems are applicable to every industry and service where reliable movement of material is essential and where large initial loads are moved irregularly or intermittently.

The economies obtainable are best evidenced by use and continued extension of such systems in many

FIG. 1. HAND FIRING DIRECT FROM THE CAR

power plants, foundries, machine shops, paper mills, steel mills, gas works, coaling stations, etc.

A railway system without provision for power on the cars can be profitably applied almost wherever the movement of material is done by hand truck or wheelbarrows and averages 3 or more tons a day. One man, for instance, with a shop car should easily be able to move on level track, a 1-ton load that could not be handled in the same time with wheelbarows by 5 men.

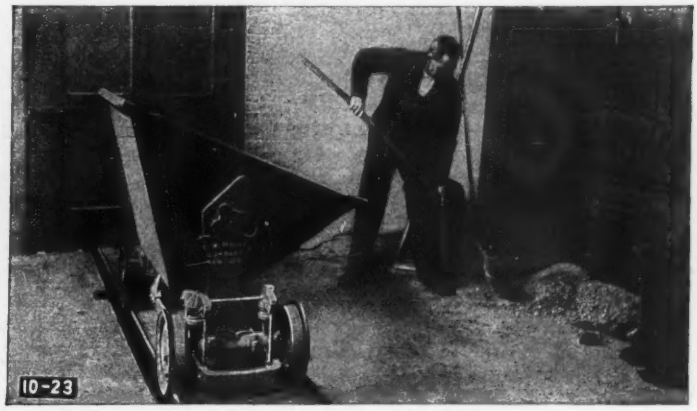


FIG. 2. INDUSTRIAL TIP CAR FOR HANDLING ASHES

A railway system involves no operating expense when not in use and is immediately available for peak loads. The car platforms can be adapted in size and height to suit best the carrying conditions as well as for ease of loading and unloading. Accurate weight of material while on the cars is easily obtainable by putting platform scales at any convenient point in the track system.

A narrow gage railway system can be laid out by anyone familiar with the points to be reached. There is seldom any part of a plant or building to which the tracks cannot be extended, and if the system is properly laid out there should be no inconvenience in getting the cars from any one point to any other on the lines. The track can usually be laid on any form of floor or road bed and can be run across or between standard gage railway tracks without cutting the rail heads. Any requirement of easily crossing rails with hand trucks or other vehicles can be met by filling in around or inside the tracks with concrete, boards, etc.

The illustrations show practical application based upon the Hunt Industrial System, the parts of which are manufactured by the C. W. Hunt Co., West New Brighton, N. Y. In this system, the standard gage of track is 21½ in., measured from outside to outside of rail heads and loaded cars of standard width require a passage of 4 ft. clearance. In the Hunt system the track sections, switches, frogs, crossovers, etc., are made up on the interchangeable sectional unit plan, and should the movement of material change or extensions be required, this unit system of construction lends itself in a most flexible way to such changes or additions.

By employment of flexible running gear and outside flanged wheels on the cars and a special construction on the outer rail of curves, a loaded car runs around a curve of as small a radius as 12 ft., as safely and requiring as little power as on straightway. It is evident that with such flexibility of the system, the cars can reach any point that could be reached by trucks and wheelbarrows, including the movement of cars to different floors by elevators.

NEWS NOTES

THE AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., announces that it has removed the Chicago office from the Monadnock Block to the ninth floor of the First National Bank Building. In this office there has been organized a general engineering department under the management Byron T. Gifford, formerly associated with the Central Station Engineering Co., Chicago.

Arthur E. Duram will be associated with the engineering staff and Charles A. Gillham has entered the contracting department of the Chicago office. These gentlemen were also formerly connected with the Central Station Engineering Co. James A. Bendure is now associated with the contracting department at the main office.

THE BROWNELL CO., DAYTON, OHIO, write us as follows: "We are much pleased to advise that our shops are busier than they have been for 4 or 5 years and that the prospect for future business never was as good as it is now."

ROBERT R. KEITH, formerly of the Sterling Machine Co., of Norwich, Conn., has become connected with the Sheffield Car Co., of Three Rivers, Michigan.

THE CANADIAN BUSINESS of the Morehead Mfg. Co., of Detroit, Michigan, manufacturers of the Morehead System of Steam Line Drainage and Boiler Feeding, has grown to such proportions in the past few years as to make necessary the organizing of the Canadian Morehead Mfg. Co., Ltd., with headquarters at Woodstock, Ontario. The new Company is incorporated under the laws of Ontario with the following officers: A. Fitzgerald, president; D. E. Stott, vice-president; Geo. H. King, secretary, treasurer and general manager.

The Morehead line of non-return, return, vacuum and condenser steam traps will be manufactured under direct supervision of Geo. W. Cole, who has represented the Morehead Mfg. Co. for the past 9 yr, and whose long and successful experience with steam trap and drainage systems assures that the product of the company will be of the highest quality.

ON JULY 1, The Brownell Co., of Dayton, Ohio, manufacturing high grade engines, boilers, feed water heaters, tanks, etc., opened a District Office at No. 1418 Oliver Building, Pittsburgh, Pa., in charge of B. S. Rederer.

BOOKS AND CATALOGS

PRACTICAL AERONAUTICS, by Charles B. Hayward, 6½ by 9½ in., bound in cloth, 770 pages. Price $3.50. This comprehensive book gives a complete history of aeronautics to the present time. Descriptions of simple balloons and dirigible balloons and accounts of the early experiments with this type of air ship are followed by a comprehensive treatise on the theory of aviation. Various types of aeroplanes are described and discussed and the details explained. Directions for building several types of aeroplanes are given and considerable space is devoted to the art of flying. The book concludes with a discussion of aviation and its future and a glossary of terms used in connection with aeronautics.

MODERN ILLUMINATION THEORY and Practice by Hortsmann and Tousley; 273 pages, 4½x7 in., flexible covers. Chicago, Frederick J. Drake Co. This book is intended for the practical workman rather than the student of mere theoretical consideration. The aim has been to give as much of the theory as is needed for a thorough comprehension of the underlying principles of illumination.

FARM GAS ENGINES by H. R. Brote; 198 pages, 5 by 7 in., cloth, illustrated with original drawings. Price $1.00. The Gas Engine Publishing Co., Cincinnati, O., are the publishers. This book is intended for the use of farmers who operate gas engines. The action of the parts necessary to the successful running of a gas engine is described in simple language so that it can be readily understood by the layman.

BUILDING AND FLYING AN AEROPLANE, by Charles B. Hayward; 5½ by 8½ in., bound in cloth, 142 pages. Price $1.00. This book was written as a guide to the amateur aviator in the construction and operation of an aeroplane. The author points out the mistake made by nearly all amateurs in following their own designs, rather than following standard designs based on years of practical experience, until experience and maturer knowledge is well founded.

The first chapter is devoted to building models and those that follow take up the making of standard designs. Considerable space is devoted to the art of flying and accidents and their lessons. The book concludes with a review of the present status of the patent situation covering flying machines.

PROGRESS, by Elbert Hubbard; a story for executives and engineers. While it is known that the engineering profession is the most progressive in the world, it is not on the face of it evident why Elbert Hubbard should be writing a book on this subject addressed to engineers. As one turns the attractive pages, however, it is discovered that this booklet is a dissertation in Hubbard's characteristic style on the making and development of steam engine indicators and the progress they have made

possible in steam engines because of their use. It is an interesting booklet and one which the busy engineer will find restful and attractive reading. At the end is one of the preachments which Hubbard usually winds up with, encouraging the engineer to be progressive and to own an indicator. Incidently he recommends the American Thompson Improved Indicator, to his readers. Copies of the booklet may be had by writing the American Steam Gauge & Valve Mfg. Co., Boston, Mass., and mentioning Practical Engineer.

PRACTICAL MATHEMATICS & GEOMETRY, Part 2, Advanced Course, by E. L. Bates and F. Charlesworth. 786 pages with illustrative diagrams; in cloth binding, price $1.50.

This is a continuation of the excellent book previously published by the same authors and having the same title but containing the more elementary mathematics. In the earlier book are taken up the graphical methods for solution of problems, algebra and the use of equations, the table of logarithms and the solution of the right angle triangle.

In the present volume there are taken up trigonometry and its applications; the meaning of algebraic equations as applied to curves and the results of tests; ellipses, hyperbolas, parabolas, their qualities and how to draw them; vector diagrams and their use in solving problems on forces; geometry showing how to get perspective and projections and how to develop intersections of irregular shapes such as cones with cylinders, squares with cylinders and the intersection of irregular curved surfaces. The second volume is more distinctly mathematical than the first and has less of practical value to the man in the shop. It is, however, important to the man who is engaged or expects to engage in the design of machinery or structures and is simpler and more practical than works that have previously been devoted to this subject.

WHAT SCALE DOES TO BOILERS, the interesting and comprehensive compilation of data on the care and treatment of boilers, published by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., now appears in the fourth edition, with up-to-date and amplified statistics and considerable new matter of an engineering nature, especially in regard to recent theories and discoveries in connection with the corrosion of iron by boiler feed water. It is interesting to note that for a period of at least six years the statistics of the leading boiler inspections and insurance companies have shown that in each year approximately 50 per cent of all the boilers examined by them were defective in ways traceable to bad feed water. A new chart, credited to Dr. Reutlinger of Cologne, shows that boiler plates covered with scale may rise to temperatures 2 to 3 times as great as will clean plates, transmitting heat at the same rate. An interesting confirmation of the inference to which this leads as regards the effective life of boilers is furnished by figures quoted from "The Locomotive," the official organ of the Hartford Steam Boiler Inspection and Insurance Co. These tests showed that specimens taken from the parts of the boiler not subject to overheating were practically as strong and as good as when first installed, but that in specimens taken from parts exposed to overheating, both the elastic limit and the elongation had fallen off considerably. The chapter on corrosion, particularly that section relating to the role of air in corrosion, in which the latest results of Professors Woodbridge and Walker, of the Massachusetts Institute of Technology, Burgess of the University of Wisconsin, and Hoyn and Bauer of Germany, are quoted, should be carefully studied by anyone having trouble of this kind. The most valuable result brought out by these investigations is the fact that corrosion may be wholly or almost entirely prevented by heating the water by spraying through an open steam bath, thereby driving off the air and other gases. Copies of this 40-page booklet will be sent free to those interested, upon application.

PIPE CUTTING and threading machinery made under the Forbes patents for hand, belt or electric power is described in Edition No. 14 of the catalog of the Curtis & Curtis Co., Bridgeport, Conn. The cata-

log tells the story of these machines completely showing each style and size of machine and explaining just what it will do. The Curtis Patent Nipple Holder and The Curtis Patent Pipe Threading attachment for lathes are also interesting devices which are described.

RIDGWAY DYNAMO & ENGINE CO. has issued 2 interesting bulletins, No. 26 describing Motor Generator Units, and No. 25 Direct Current Generators. The assembly and detail illustrations are particularly clear and instructive and the text specially well brings out the points of interest. The bulletins may be had from the company at Ridgway, Penna.

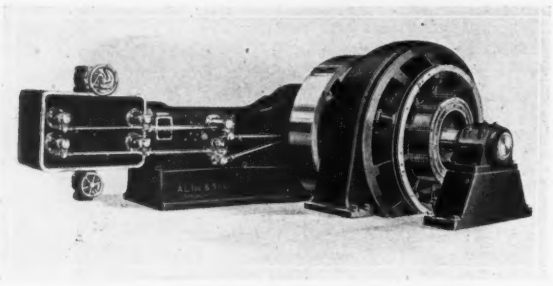
5003 IS THE FORM number of a 20-page 6 by 9 bulletin, just received from Ingersoll-Rand Co., 11 Broadway, New York City, New York, descriptive of the Radialaxe Air Driven Coal Cutters as manufactured by them. These machines are especially adapted for undercutting in a pitching seam; shearing seams (particularly entries); mining near the middle of the seam; cutting out veins or bands of fire clay or slate in the coal seam; mining under or above such seams so that the dirty material can be loaded without mixing with the coal—and driving entries or headings. Catalog shows the various styles of mountings required for each particular line of work, and contains several illustrations of machine at work under ground. A descriptive table on the last page gives the various sizes and capacities.

GRINNEL AUTOMATIC SPRINKLER Bulletin for July, 1912, has been received. This bulletin is issued by General Fire Extinguisher Co., and contains much information relative to the prevention of serious conflagrations by the use of sprinkler systems.

THE AMERICAN STEAM Gauge and Valve Mfg. Co., Boston, Mass., has issued an attractive booklet entitled "The American Thompson Improved Indicator," which in addition to this instrument, illustrates and describes gages, valves, recording instruments and kindred appliances.

NELSON STEEL VALVES and Fittings is the title of Catalog S, recently issue by the Nelson Valve Co., Philadelphia. It is an artistic book of 65 pages and is a forerunner of a new, complete catalog which will cover a complete line of the Nelson valves and fittings.

A. L. IDE & SONS, Springfield, Ill., are sending engineers free upon request an 8½ by 11 picture of the



Ideal Corliss valve engine, suitable for framing for their engine room.

NEW PUBLICATIONS issued by the Department of the Interior, Bureau of Mines, are: Bulletin 41, Government coal purchases under specifications, with analyses for the fiscal year 1909-10, by G. S. Pope, with a chapter on the fuel-inspection laboratory of the Bureau of Mines, by J. D. Davis, 1912. Technical Paper 5, the constituents of coal soluble in phenol, by J. C. W. Frazer and E. J. Hoffman, 1912. Technical Paper 9, the status of the gas producer and of the internal-combustion engine in the utilization of fuels, by R. H. Fernald, 1912. Technical Paper 19, the factor of safety in mine electrical installations, by H. H. Clark, 1912. Technical Paper 20, the slagging type of gas producer, with a brief report of preliminary tests, by C. D. Smith, 1912. Reprint of Bulletin 39, the smoke problem at boiler plants, a preliminary report, by D. T. Randall, 31pp. Reprint of United States Geological Survey, Bulletin 334, revised by S. B. Flagg. The Bureau of Mines has copies of these publications for free distributions, and in asking for publications order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

THE MODERN BOILER TUBE is the title of an attractive bulletin recently issued by the National Tube Co., Pittsburgh. It gives a story of the evolution and development of the boiler tube, some expert opinions on its efficiency and is illustrated by Standard mill tests.

THE GENERAL ELECTRIC COMPANY has just issued Bulletin No. 4951, which is devoted to Street Lighting with Edison Mazda Series Lamps.

BULLETIN NO. 4952, recently issued by the General Electric Company, is devoted to a description of the Series Incandescent Street Lighting System as furnished by that Company. This bulletin supersedes the Company's previous bulletin on this subject.

FORT WAYNE ELECTRIC WORKS bulletin 1134 descriptive of Northern types B and BR Form C motors has been received.

THE JULY NUMBER of The Valve World marks the first distinct change in the appearance since the first number was issued in January, 1905. The size of the standard magazines has been adopted in order that it may be delivered to readers unfolded and in a form more readily kept on file for reference; and as it is proposed to make each number of more or less permanent value.

So far as policy is concerned there has been no material change. It always has been the aim of The Valve World to give its readers the most interesting and useful information obtainable within the range of subjects properly falling within the scope of the business conducted by Crane Co.

SHERWOOD MFG. CO., Buffalo, N. Y., have recently issued Catalog 15, describing steam and gasoline appliances. Among the specialties illustrated may be mentioned "Buffalo" injectors, ejectors, oil pumps and oil cups, flue scrapers and flue blowers.

WORK HARD; play hard; smile often, and keep your eyes on the "main chance," is a good piece of advice taken from the June issue of Cord Age, a live booklet issued by the American Mfg. Co., to keep its product, American Rope, before the dealers and users.

BULLETINS DESCRIPTIVE of power plant appliances including closed feed-water heaters, open feed-water heaters and purifiers, and steam separators, water softeners and hot water heaters make up a very complete and attractive catalog of steam specialties with full and complete illustrations, descriptions and dimensions. Issued by The Sims Co., of Erie, Pa.

A NEW PUBLICATION recently issued by the Lagonda Mfg. Company of Springfield, Ohio, entitled "Some Points of Superiority of the Lagonda Water Strainer," gives considerable practical information on the installation and operation of water strainers for power plant purposes. It points out how a Lagonda type of strainer saves valuable floor space in an engine room, as large pits are not necessary, the whole strainer can be buried under the floor with only the top and hand wheel exposed. Other interesting and practical points are also brought out. Copies of this booklet may be had by addressing the Company at the above address and mentioning Practical Engineer.

THE IDEAL CORLISS VALVE ENGINE, a modern high economy unit with patented nondetaching valve gear and valves in the cylinder head is described in bulletin No. 20 issued by A. L. Ide & Sons. of Springfield, Ill. This catalog is notable for its clean cut illustrations, the clear explanations of why this is the ideal valve gear and an explanation of the economy guarantee of $1000 for each pound of steam used in excess of the rate specified in the contract. It is a bulletin worth reading.

A CATALOG, issued by The American District Steam Co., entitled The Right Amount of Heat in the Right Place at the Right Time gives a refreshing chill in hot weather days by its winter scene on the cover and then points out how by means of the atmospheric system of steam heating and the Adsco graduated valve it is possible with low pressure of steam to get the right temperature in any sort of weather with a considerable saving of fuel. The system is applicable to private houses, apartments and factories.

A BOOKLET issued by William S. Haines & Co., Philadelphia, Pa., shows the operation of the Haines automatic valve for vacuum and vapor heating.

KEARSARGE ASBESTO-METALLIC Packing is the subject of an interesting booklet sent out by the H. W. Johns-Manville Co., at Williams St., New York City.

FORT WAYNE ELECTRIC WORKS of General Electric Company are distributing Bulletin 1142 describing its 1912 line of electric fans. The book is artistically printed and lists a large variety of types.

FERRO ENGINES, a practical treatise published by the Ferro Machine & Foundry Co., of Cleveland, Ohio, shows by diagrams and full descriptions how a marine gasoline engine operates, the action of the carburetor, ignition and the details of make and break igniter, details of construction of the engine parts and the different types and sizes of engines built by the company. The book, which contains 50 large pages, is interesting, instructive and worth while.

FROM FORT WAYNE ELECTRIC WORKS we have received Bulletins 1136, 1137 and 1140, describing direct connected Type MPL d.c. generators; Form B revolving field alternators and single phase repulsion induction motors respectively. Accompanying the bulletins was a handsome booklet, entitled Fort Wayne Motor Drives.

THE LUNKENHEIMER CO., Cincinnati, O., has recently issued its 1912 catalog, a book of nearly 700 pages 5 by 7 inches bound in cloth. The book is a comprehensive treatise on Lunkenheimer steam specialties including, brass, iron, semi and cast steel valves, whistles, cocks, gages, injectors and many other devices.

AMERICAN BLOWER CO., Detroit, Mich., has issued Bulletins 334, 340 and 344, describing "A B C" types A and E vertical self-oiling engines; Sirocco fans and blowers; "A B C" cast iron blowers and exhaust fans. A number of booklets accompanied the bulletins which set forth the meritorious features of "A B C" apparatus.

SMOOTH-ON INSTRUCTION BOOK No. 10, and a booklet describing the varied uses of Smooth-On iron cement No. 7, have been received. Many applications of Smooth-On products are illustrated and described.

A SILENT WORKER is the title of a 4-page pamphlet received from the John F. Robertson Co., Pittsburgh, Pa., explaining the advantages and mechanism of the Robertson noiseless rotating check valve. Accompanying this pamphlet is another of 4 pages in which the Little Giant boiler tube extractor is described.

PHILADELPHIA GREASE MFG. CO. has sent us its booklet, entitled The Quality Lubricant, in which are given the uses and instructions for use of various densities of Philadelphia grease. Several types of compressed air, hand compression and spring compression grease cups are also listed in the bulletin.

THE EXTENT TO WHICH electric drive is being applied to the shoe and leather industry, and the advantages to be derived from this application, are shown in Bulletin No. 4931, recently issued by the General Electric Company. The bulletin contains illustrations and descriptions of various installations of this nature.

RECENTLY THE E. C. SQUIRES CO., Cleveland, Ohio, has issued a circular describing the Squires improved steam trap.

"VELOOS" BALATA BELTING is the title of a circular recently issued by Manheim Manufacturing & Belting Co., Manheim, Lancaster Co., Pa.

AN ATTRACTIVE CATALOG issued by the "S-C" Regulator Co., Fostoria, Ohio, has been received. It describes and illustrates "S-C" water level regulators, pump governors, etc.

PRECISION INSTRUMENT CO., of Detroit, has just published Supplement 2, Catalog D Revised, which describes carbonic acid gas and corrosive gas recorders, giving the principles of operation and illustration of the instruments.

GENERAL ELECTRIC COMPANY has just issued Bulletin No. 4939, which is descriptive of electric hoists manufactured by that company. This bulletin supersedes a previous bulletin on the same subject.

BULLETIN 4947, just issued by the General Electric Company, is devoted to the illumination of electric railway cars and the advantages possessed by Edison Mazda and Gem lamps for this service. The bulletin contains illustrations showing the illumination of cars by these two types of lamps as compared with that resulting from the use of the old carbon filament lamp. The bulletin should be of great interest to railway men and should help solve their lighting problems.

THE STEWART HEATER CO., Buffalo, N. Y., has issued a booklet, entitled 413,637 Horsepower, which contains a list of 1600 users of Otis feedwater heaters, together with numerous testimonials.

SWAIN LUBRICATOR CO., 250 Lake St., Chicago, has issued two booklets, one entitled Perfect Lubrication, illustrates and describes the Swain lubricator, and the other is devoted to the subject of Swain metallic packing.

BULLETIN NO. 8, issued by the Weston Electrical Instrument Co., Newark, N. J., illustrates and describes Weston miniature precision direct current instruments, both in portable and switchboard types.

RAILWAY AND LIGHTING DEPARTMENT of the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa., has issued Circular No. 1094, describing Westinghouse turbo-alternators.

FROM THE ST. JOHN GRATE Bar Co., Philadelphia, we have received a booklet describing Wellough-by's St. John patent improved shaking grates and furnaces.

CIRCULARS HAVE BEEN RECEIVED from the Goetze Gasket & Packing Co., of New Brunswick, N. J., describing first the Devo gaskets, made of corrugated steel with asbestos covering; second, Goetze metallic packing, Style D, for use on steam engines, valve stems and steam pumps; third, metallic packing, Style B, with bronze and white metal rings for high speed engines; fourth, special metallic packing designed for use on air compressors. Full illustration and description of each of these styles is given in the circulars.

BULLETIN 400C, ISSUED BY THE HYATT Roller Bearing Co., of Newark, N. J., shows the construction of these bearings for different purposes, illustrating the savings which may be made by their use and giving test figures to show what these savings have been in actual service. The bulletin also includes drop heads for hangers, post hangers and boxes.

ZIERMORE boilers feed regulators are fully described in a 4-page pamphlet designed for engineers by the Ziermore Regulator Co., Johnsonburg, Pa.

FROM THE RUSSELL ENGINE CO., Massillon, Ohio, we have received Bulletin A, describing the Russell 4-valve engine and an attractive catalog on the subject of the Massillon feed-water heater, purifier and oil extractor.

STRONG STEAM TRAPS, EVERY TRAP GUARANTEED, is the title of a pocket size catalog containing interesting information and recently received from Strong Carlisle & Hammond Co., of Cleveland, Ohio.

THE BLAKE PROCESS OF USING POWDERED COAL is described in a pamphlet sent out by the Blake Crusher & Pulverizer Co., 643 Fulton Bldg., Pittsburgh, Pa. It explains the process and gives the results of some tests made with pulverized fuel by this method.

NOTES FOR THE MAN who makes up the specifications are being sent out by the Goulds Mfg. Co., in the form of a reminder catalog showing the title pages of the different bulletins issued by the company. Bulletin 112 contains Handy Data on Power Pumping; No. 100 on Double-Acting Piston Pumps; 101, 102, 103, 107, on Triplex Plunger Pumps of Various Styles; 104 Double Acting Triplex Piston Pumps; 105 Single Stage, Single Suction Centrifugal Pumps; 106 Vacuum and Stuff Pumps; 108 Deep Well Working Heads; 109 Pumps for Special Service; 110 Single Stage, Double Suction Centrifugal Pumps.

A NEW ANALYSIS OF THE CYLINDER Performance of Reciprocating engines, by J. Paul Clayton, has just been issued as Bulletin No. 58 of the Engineering Experiment Station of the University of Illinois.

This bulletin contains the results of an extensive investigation of indicator diagrams from engines using steam, gas, air, and ammonia. It has been found that the actual steam consumption of an engine may be computed by a new method from the indicator diagram alone to within 4 per cent of the results obtained by tests. New methods have also been devised for detecting leakage from the indicator card, for computing the amount of the clearance volume, and for closely locating the cyclic events.

Copies of Bulletin No. 58 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

THE INDICATOR BOOK is the title of an attractive 48-page catalog recently issued and now being distributed by the Thrill Indicator Co., Corry, Pa. Besides containing a full description of the various types of indicators, reducing wheels, indicator fittings, planimeters, etc., manufactured by the company, the book also contains a large amount of matter of decided interest to engineers, which includes discussions and criticisms of a number of typical indicator diagrams, instructions for drawng expansion curves and combining the cards of compound engines, while the pages on indicating gas engines contain full instruction for interpreting and taking gas engine indicator diagrams, instruction on setting valves, giving much new and original information on this little known subject. The catalog is handsomely bound, and copies will be sent free to engineers upon application.

TRADE NOTES

NASHUA MACHINE CO., maker of the Bundy Steam Trap, has appointed as its selling agent in New York, W. E. Van Keuren of Jersey City, N. J., who for many years has been a trap expert on the Bundy trap.

THE POTOMAC ELECTRIC LIGHT COMPANY, Washington, D. C., has recently ordered for its Bennings plant 4 Taylor stokers, each having 7 retorts and extension grates and to be used on 600 hp. B. & W. boilers. For many years this plant has had the reputation of being one of the most economical stations in the country and Taylor stokers are to replace those formerly used.

THE OHIO BLOWER CO. has removed from 324-332 Prospect Ave., N. W., Cleveland, Ohio, where their business in cast-iron exhaust heads, steam and oil separators, and rotary ball bearing ventilators, has developed until it has completely outgrown the facilities. The new works are located at 5125 Perkins Avenue, Cleveland, where practically triple manufacturing space is available in the commodious 3-story building which now serves for the more effective handling of the business.

THE AMERICAN ENGINEERING CO., manufacturers of the Taylor Stoker, report recent sales of stokers as follows: General Electric Co., Pittsfield, Mass., 2 stokers; Worcester Suburban Co., Uxbridge, Mass., 2 stokers with extension grates; The Philadelphia Electric Co., 12 stokers; The Proctor & Gamble Co., Ivorydale, Ohio, 12 stokers; Fisk Rubber Co,. Chicopee Falls, Mass., 2 stokers; The Frederick & Hagerstown Power Co., Hagerstown, Md., 3 stokers; The Stone & Webster Engineering Corporation, for the Republic Ry. & Light Co., Lowellville, Ohio, 6 stokers; Crescent City Slaughter House & Stock Yard Co., New Orleans, 3 stokers.

RECENT SALES OF CORLISS engines made by Allis-Chalmers Co., Milwaukee, include 29 units, as follows: 10, 13 and 20 by 30 in. and 8, 18 and 28 by 30 in. vertical cross compound machines to the Columbia Plate Glass Co., Blairsville, Pa.; one 18 by 42 in. engine direct connected to an electric generator for the Excelsior Springs Water, Gas & Electric Co., Excelsior Springs, Mo.; one 32 by 60 direct geared heavy duty engine for installation in Cuba; one 16 by 30 in. belted engine for the Chicago & Riverdale Lumber Co., Riverdale, Ill.; one 16 by 36 in. belted engine for the Landau Cabinet Co., St. Louis, Mo.; one 14 by 24 in. belted engine for installation in Mexico by the Yoquivo Development Co.; one 14 by 30 in. engine direct connected to an electric generator for the plant of the Selby Smelting & Lead Co., Selby, Cal.; one 30 by 30 in. sugar mill engine for shipment by the American Trading Co., New York; one 18 by 42 in. belted engine for the Kurth Co., Milwaukee, Wis.; one 48 by 42 in. low-pressure engine for the Marion Mfg. Co., Marion, N. C.; one 30 and 64 by 54 in. cross compound engine direct connected to an electric generator in the power house of the American Smelting & Refining Co., Perth Amboy, N. J., and one 16 by 36 in. belted engine for the Northwestern Leather Co., Manistique, Mich.

Gas engine sales include 4 44 by 60 in. twin tandem units, with generators, for the Indiana Steel Co., Gary, Ind., and 4 44 by 60 in. machines coupled to generators for the Minnesota Steel Co., New Duluth, Minn.

The above represents an aggregate capacity of 70,000 hp. on orders placed during the latter part of June.

Sparks From The Advertising Pages

Mr. Thomas L. Robinson, of Fort Madison, Iowa, writes that there are two classes of thoroughly competent engineers—those who have a wide knowledge of equipment and those who do not; and in making this statement he adds that there are far too many of the latter class—men who are caused no end of trouble and worry simply because they do not take pains to see that their equipment is the best obtainable.

He cites a definite instance to illustrate his point—a case which came under his own observation.

"Sometime ago," he says, "an engineer friend of mine, who operated a lighting station, called on us in our engine room and after being shown about, he noticed the beautiful dark brown color and glossy, smooth polish of our piston rod. He asked how we managed to keep it in such good condition, saying that his rods looked as though they had just come out of the lathe after having received a vigorous turning.

"His stuffing boxes looked badly, too, he said, and were in decided contrast to ours. Furthermore, he had to pack his engine every few days, while our box had been packed about 18 months ago, since which time we had scarcely given it a thought.

"I asked him whether he made it a point to read advertisements of packing and other accessories and he said that he did not. Furthermore he stated that he had no time to read power plant papers, for he was kept busy replacing and fixing up things which had proven inefficient.

"I wondered how much of this time he would be saving if he did his buying through Practical Engineer's advertising section, so I got a copy of the paper and showed him several advertisements of rod packings that would meet his requirements. He had never seen or heard of any of them and he wanted to know if they would work on a high speed engine. I told him that they would and added that if he cared to write to them, any of the firms who advertised would be glad to give him any information which he might desire.

"This is my message to engineers everywhere: Read the advertisements. They direct you to success in your profession as nothing else can. They keep you full of the engineering spirit. They tell you many things, which, because of their nature, have eluded detection, but which are great truths made simple by many hours of painstaking work on the part of our brainiest mechanics and engineers. They tell you what to look for and where to look for it. They increase your ability and your value correspondingly, with the result that sooner or later there is bound to be something more in the pay envelope."

Good for you, Mr. Robinson. We agree. So do scores of engineers who have derived personal benefit by traveling the route which you have outlined.

We like your reference to keeping up the engineering spirit. That's what the big conventions are for. Here one meets his fellow engineers, listens to their experiences, profits by their suggestions. He sees the new and the best equipment displayed and he appreciates the improvements shown. His interest in his profession becomes enthusiasm.

Constant association with up-to-date technical advertising has the same effect. All that is new and good and worthy of appreciation is kept before you. You can't help but feel enthusiastic over your work—proud of the profession you are following.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—Sales Engineer, experienced manager with intimate acquaintance among engineers and architests, is arranging to represent manufacturers of power plant and steam heating material. Is arranging to take few allied items of high grade and superior merit that require representative with thorough knowledge of modern plant installation and a thorough experience in business relations with specifying engineers. Have been engaged in this work for past six years, connected with number of professional and social organizations. Will assemble lines immediately. Address Box 236, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 8-1-1

POSITION WANTED—By an engineer, 20 years experience in central stations. Strictly sober. Married. Age 38. Address Box 234, Practical Engineer, Chicago, Ill. 8-1-2

POSITION WANTED—As oiler. Have had four and one-half years experience both in hand firing and with stokers. Good references, sober and steady worker. Married, age 24 years. Address Box 237, Practical Engineer, Chicago, Ill. 8-1-1

POSITION WANTED—Engineer with eighteen years experience in erecting, operating and repairing refrigerating, electric power, pumping, and steam heating plants. Sober and industrious. License and references. Address Box 235, Practical Engineer, Chicago, Ill. 8-1-1

POSITION WANTED—As chief or operating engineer, 10 years' experience on all kinds of steam and electrical power plant machinery. Age, 38; temperate, steady and reliable. Chicago City and State of Minn. chief engineer's license. Address Box 228, Practical Engineer, Chicago, Ill. 7-15-1

Help Wanted

AGENTS—AT ONCE. Something new. Model Spring Winder. Guaranteed for life. Makes springs any size from any kind of spring wire. Wonderfully rapid. Efficient and powerful machine. Sells quickly to factories, shops, mills, garages, printing houses, newspaper publishers, etc. Indispensable wherever there's a machine with springs on it. Saves time, worry and money. Attaches in a minute to any workbench or table. Sell one, make $2.50 profit. You can sell 10 a day. Big folder tells all. Write National Mfg. & Sales Co., 322 Huron St., Toledo, O. 7-1-3

WOULD ONE HUNDRED DOLLARS per week interest you? Would you like to be outside in the fresh invigorating air during the coming months? Free to do your own bidding and earning $100.00 or more per week, as you choose? Your own boss. We want one first-class salesman to represent us, in every city in the United States, to sell our high-grade specialties to Engineers. Exclusive territory given. Strong Machinery & Supply Co., 48 Franklin St., N. Y. C. tf

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf

WANTED—SALES AGENTS to sell Goetze Metallic Packings of good reputation. Write us. Goetze Gasket & Packing Co., New Brunswick, N. J. 6-15-12

Wanted

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

WANTED—SALESMEN TO WORK counties calling on voters for our New Census publications. Largest publishing house in the world back of you. Permanent if satisfactory. Establish your future now. Men making $50 to $75 per week. Rand McNally & Co., Dept. B, Chicago, Ill. 8-1-5

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

For Sale

FOR SALE—HIGH PRESSURE BOILERS 54x16, 60x16, 66x16, 72x18. Corliss Engines 10x30, 12x36, 14x36, 16x42, 18x36, 18x42. Generators, Motors, Miscellaneous Machinery. The Randle Machinery Co. 1767 Powers St., Cincinnati, Ohio. 7-15-tf

FOR SALE—100 H. P. SCOTCH MARINE boiler, Hartford insurance 125 lb., 18 months old. Triple riveted, butt-seam, $500 f. o. b. Sunbury, Ohio, also 12x36 Harris Corliss engine, $400, Duzets & Son, 44 Church St., New York. 7-15-2

FOR SALE—INDICATOR, REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment, Price low—in fact, a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf

FOR SALE—WAINWRIGHT HEATER, 400 H. P. copper corrugated tubes, excellent condition, low price, Harris Machinery Co., Minneapolis, Minn. 7-1-6

Patents and Patent Attorneys

WE SELL PATENTS. Established ten years. To buy or having one to sell write Charles A. Scott Co., 1098 Granite Bldg., Rochester, N. Y. 8-1-6 e.o.i.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf

FIND OUT FOR YOURSELF what to invent and how to protect it. My book, "Inventors' Universal Educator," covers the matter from A to Z; also gives 600 Mechanical Movements and 50 Perpetual Motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C.

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